U.S. Bureau of Reclamation

Mid-Pacific Region

Shasta Lake Water Resources Investigation,

California

Mission Statement Milestone Report

March 2003

EXECUTIVE SUMMARY

The primary purpose of this Mission Statement Milestone Report (Report) is to define a concise mission statement of the Shasta Lake Water Resources Investigation. This primarily includes a process of identifying pertinent water and related resource problems, needs, and opportunities; planning objectives for the feasibility study; and constraints, principles, and criteria under which plan formulation is to be accomplished. This Report highlights: significant water resources and related projects and programs, existing and potential without-project future conditions, development of the mission statement, potential water resource management measures and concept plans, a public outreach program strategy, and major future actions.

BACKGROUND

The U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region (Reclamation) in 2000 re-initiated a feasibility scope investigation to evaluate the potential of enlarging Shasta Dam for increased water supply and operational flexibility. Increases in demands for water supplies and attention to ecosystem needs in the Central Valley of California have renewed interests on expanding the facility. The Shasta Lake Water Resources Investigation is being conducted under the general authority of Public Law (PL) 96-375 (1980).

The Shasta Dam and Reservoir Project was completed in 1944 by Reclamation for the purpose of flood control, irrigation water supply, municipal and industrial (M&I) water supply, hydropower generation, fish and wildlife conservation, and navigation. The 533-foot high (above streambed) Shasta Dam and 4.55 million acre-foot (MAF) reservoir are located on the upper Sacramento River in Northern California about 9 miles northwest of the City of Redding. The Shasta Dam Project significantly influences flows and other water conditions in the Sacramento River as far downstream as the Sacramento-San Joaquin River Delta.

A number of existing projects influence water resources studies for the Shasta Lake Water Resources Investigation. Examples include Reclamation's Central Valley Project (CVP), the State of California's State Water Project (SWP), and Sacramento River Flood Control Project by the U.S. Army Corps of Engineers (Corps). In addition, there are numerous water resources programs that significantly effect activities within the region. Two of the most influential programs are activities related to the Central Valley Project Improvement Act (CVPIA) and the CALFED Bay-Delta Program. This investigation is being accomplished recognizing the goals and objectives for these and other water resources projects and programs.

- **CVPIA –** The CVPIA, signed into law in October 1992, fundamentally changed authorization of the CVP by including fish and wildlife protection, restoration, and mitigation as project purposes. The CVPIA identified a number of specific measures to accomplish the new purpose. To address anticipated impacts of these measures on deliveries to CVP agricultural and municipal contractors, CVPIA directed Reclamation to prepare a plan to identify a least-costly plan to increase the yield of the CVP an amount equal to the redirected supplies. Reclamation is in the process of preparing this plan.

- **CALFED –** The CALFED Bay-Delta Program is a cooperative effort among the State of California, various Federal agencies, and involved environmental, urban, and agricultural

communities and organizations to address resources problems consisting of water quality, ecosystem quality, water supply reliability, and levee system integrity. CALFED program implementation began following circulation of the final programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR), and the signing of the Record of Decision (ROD) in August 2000. The Preferred Program Alternative (PPA) in the CALFED ROD consists of programmatic elements, which set the long-term direction of the program to meet its mission statement and objectives. The water storage program and seven interrelated programs in the PPA consists of actions to expand surface storage capacity in the Central Valley by approximately 4.5 MAF and implement a major expansion of groundwater storage by an additional 0.5 to 1.0 MAF. Enlarging Shasta Dam is one of five surface water projects identified in the PPA.

PROBLEMS AND NEEDS

Based on existing and potential future physical, environmental, and socio-economic conditions in the study area, the major identified water resources and related problems and needs include:

- **Anadromous Fish Survival –** Due to a number of environmental factors, the population of Chinook salmon has declined in the Central Valley. To address this problem in the Sacramento River, various actions have been undertaken ranging from establishing minimum flow requirements in the river to structural changes at Shasta Dam. There is still, however, a residual need for effective actions to benefit the salmon, especially in the dry and critically dry years. The need for cooler water will likely increase should requirements contained in the December 2000 ROD for the Trinity River Decision, which will reduce diversions of cooler water from the Trinity River to the Sacramento River, be implemented.

- **Water Supply Reliability –** Demands for water in California exceed available supplies. As the population of the Central Valley grows, the need to maintain a healthy and vibrant industrial and agricultural economy will increase as the demand for adequate amounts of water supply becomes more acute. Even with aggressive water conservation, increased water recycling, and other water management measures, demands will exceed supplies. To avoid major impacts to the economy and overall environment of California, there is a significant need to increase the reliability of water supplies to meet the future demands.

- **Other Resources Needs –** Other identified problems and needs include: the need for restoring environmental values in the Shasta Lake area and downstream along the Sacramento River; the need for additional flood control along the upper Sacramento River; growing demands for new energy sources in California; and increased need for additional water-oriented recreation in the upper Sacramento River area.

PLAN FORMULATION RATIONALE

The basic plan formulation rational for the Shasta Lake Water Resources Investigation includes: (1) identifying existing and without-project future resource conditions; (2) defining likely water resources problems and needs in the study area; (3) developing specific planning objectives, constraints, principles, and criteria, and an overarching mission statement; (4) formulating and comparing potential alternative plans to address the study objectives consistent with the mission statement; (5) selecting a plan for recommended implementation; and (6) preparing and processing a feasibility report for Congressional action. This rational is to be documented in four major study phases. The first is the Mission Statement Phase, which focuses on defining the mission statement for the Investigation. As mentioned, this first phase is the primary purpose of this Report. The second is the Initial Plans Phase, which is to identify potential resource management measures to address the study objectives and formulate, coordinate, and compare an initial set of alternative plans. This phase is to be followed by the Alternative Plans Phase for the purpose of formulating specific alternative plans to address the planning objectives; evaluate, coordinate, and compare the plans; and identify a plan for tentative recommendation. The last phase is the Recommended Plan Phase for the purpose of completing the formulation of the tentatively recommended plan and preparing, coordinating, and processing a feasibility report for Washington-level consideration.

STUDY OBJECTIVES AND MISSION STATEMENT

The identified problems and needs in relation to the study authority were translated into primary and secondary (opportunity) planning objectives that include:

- **Primary Objectives –**
  - Increase the survival of anadromous fish populations in the Sacramento River primarily upstream from the Red Bluff Diversion Dam.
  - Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes to the CVP to help meet future water demands with a primary focus on modification of Shasta Dam and Reservoir.

- **Secondary Objectives –** To the extent possible through pursuit of the primary planning objectives, include as opportunities, features to help:
  - Preserve and restore ecosystem resources in the Shasta Lake area and long the upper Sacramento River.
  - Reduce flood damages along the Sacramento River.
  - Develop additional hydropower capabilities at Shasta Dam.
  - Provide additional water-related recreational opportunities in the Shasta Lake area.

In addition to the planning objectives, a set of planning constraints, principles, and criteria were developed to help focus the planning process. The primary constraints and principles include: study authorization; applicable laws, regulations, and policies; the CALFED ROD; and guiding plan formulation principles. The fundamental planning criteria for use in comparing and evaluating developed alternatives includes: completeness; effectiveness; efficiency; and acceptability.

Based on identified problems and needs, relationships to other programs and projects, and Federal planning guidance, the following mission statement was developed:

> ***"To develop an implementable plan primarily involving the modification of Shasta Dam and Reservoir to promote increased survival of anadromous fish populations in the upper Sacramento River; increased water supply reliability to the Central Valley Project; and to the extent possible through meeting these objectives, include features to benefit other identified ecosystem, flood control, and related water resources needs."***

CONCEPT PLANS

Preliminary resource management measures are identified to address the planning objectives. From these preliminary management measures, five concepts are identified. These resource management measures and concept plans will be further developed and additional alternatives formulated as the investigation continues. The concepts include:

- **Enlarge Shasta – Low Option Concept –** This concept is primarily one of the projects identified in the CALFED ROD. Its main feature consists of enlarging Shasta Reservoir about 290,000 acre-feet by raising the dam 6.5 feet. The increased storage would be used to increase CVP system reliability and to benefit anadromous fish survival along the upper Sacramento River. The concept could also incorporate ecosystem restoration through establishment or expansion of existing riverine, riparian, and wetland resources at available locations not yet identified around Shasta Lake and along the Sacramento River upstream from Red Bluff.

- **Enlarge Shasta – Expanded Option Concept –** This concept primarily consists of enlarging Shasta Dam and Reservoir an amount larger than suggested in the CALFED ROD. Studies are continuing, however, likely increased sizes range from raising the dam 6.5 feet as in the low option concept, up to about 30 feet. Higher raises are also being assessed. The enlarged storage space would be used to help increase CVP system reliability and to benefit anadromous fish survival along the upper Sacramento River. It would also incorporate ecosystem restoration through establishment or expansion of existing riverine, riparian, and wetland resources at available locations not yet identified around Shasta Lake and along the Sacramento River upstream from Red Bluff.

- **Conjunctive Use Concept –** The major components of this concept consist of: (1) enlarging Shasta Reservoir about 290,000 acre-feet as above for water supply reliability and anadromous fish survival; (2) developing a conjunctive use storage area, either groundwater or offstream surface water storage, for carryover storage into dry years; and (3) constructing ecosystem restoration features near Shasta Reservoir and along the upper Sacramento River.

- **Non-Structural Concept –** This concept primarily consists of reoperating Shasta Dam and Reservoir for increased water supply reliability and increasing the real-time flood control operation reliability of Shasta Dam.

- **Multiple Interest Concept –** The major components of this concept include a combination of: (1) enlarging Shasta Reservoir between 290,000 acre-feet and about 1 MAF by raising the dam between about 6.5 feet and 30 feet, respectively, for water supply reliability and anadromous fish survival; (2) developing a conjunctive use storage area, either groundwater or offstream surface water storage, for carryover storage into dry years; (3) reoperating Shasta Dam and Reservoir for increased water supply reliability; (4) increasing the real-time flood control operation reliability of Shasta Dam; and (5) constructing ecosystem restoration features near Shasta Reservoir and along the upper Sacramento River.

FUTURE ACTIONS

The next major step in the feasibility study process is to expand the definition and evaluation of potential resource management measures that address the study objectives. This will include reviewing the concept plans and formulate the most applicable of the measures into various alternative plans. Future efforts will include evaluating, comparing, and refining the alternative plans, selecting and displaying a recommended plan, and completing the feasibility report. Emphasis in upcoming studies will be in plan formulation including hydraulic and hydrologic system modeling, designs and cost estimates, and environmental impact evaluations and documentation.

Major emphasis will also be placed on implementing a Strategic Agency and Public Involvement Plan (Plan) for the Shasta Lake Water Resources Investigation. The Plan is being designed as a manual to assist the Project Coordination Team to effectively communicate with those individuals, groups and agencies that are affected by or can benefit from enlargement or modification of Shasta Dam. It is anticipated that this plan will be amended as the Project evolves. It is included as an appendix to this report.

Based on completing the Initial Alternatives Phase in late-2003, a draft feasibility report and EIS/EIR could be completed for release to the public and other Federal agencies for review in mid-2005 and a final feasibility report in mid-2006. With possible Congressional authorization in 2007, detailed project designing could be initiated in 2007, followed by initiation of construction in about 2009. The initial phase of construction would include real estate acquisition, continuation of detailed designs, acquisition of necessary permits, and minor relocations. The construction period would likely range from three to six years depending on the selected plan.

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CHAPTER I
INTRODUCTION

BACKGROUND

In 2000, the U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region (Reclamation) re-initiated a feasibility scope investigation focusing on evaluating the potential to enlarge Shasta Dam primarily for increased water supply reliability and water quality improvement, with the potential to consider limited hydropower generation and flood damage reduction. This investigation is being conducted at the direction of Congress and to support other and ongoing Federal interests within the study area.

Enlargement of Shasta Lake has been considered previously. A primary conclusion by Reclamation in a September 1988 Enlarged Shasta Wrap-Up Report, was that enlarging Shasta Dam by up to 213 feet in height appeared to be feasible from engineering, environmental, and economical perspectives. However, Reclamation also concluded that plans for enlarging the dam were not financially or politically feasible given the relatively low estimated demand for additional water at that time and the extensive investment of public funds that the project would require.

Expansion of storage in Shasta Reservoir as part of the Central Valley Project (CVP) is one of five potential surface water storage projects identified in an August 2000 Record of Decision (ROD) for the CALFED Bay-Delta Program (CALFED). The ROD identified the potential for expansion of Shasta to help increase the pool of cold water available to maintain lower Sacramento River water temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.

PURPOSE AND SCOPE

The primary purpose of this Mission Statement Milestone Report (Report) is to define a concise mission statement for the Shasta Lake Water Resources Investigation. This primarily includes a process of:

- Identifying the pertinent water and related resources problems, needs, and opportunities within the primary and extended study areas being addressed in the investigation.

- Developing a specific set of planning objectives to address the identified problems, needs, and opportunities.

- Establishing the planning constraints, guiding principles, and criteria for which plan formulation and evaluation is to be accomplished.

- Defining the mission statement to support the established planning objectives.

To support defining the mission statement and further development of the feasibility investigation, this Report also includes:

- Description of significant water resources and related projects and programs including a review and update of pertinent information about Shasta Dam and Reservoir and Shasta's role in the CVP.

- Identification of without-project future physical, biological, and socio-economic conditions in the primary and extended study areas.

- Formulation of a preliminary set of water resource management measures and concept plans to address the planning objectives consistent with the mission statement.

- Description of a potential public and agency outreach program.

- Identification of potential major future actions for the feasibility investigation.

This Report will be used as a first component of the Initial Alternatives Summary Report and subsequent documents. Conclusions and recommendations are expected to evolve as studies progress into the decision document for the feasibility investigation.

STUDY AREA LOCATION AND DESCRIPTION

Shasta Dam and Reservoir are located on the upper Sacramento River in Northern California, as shown in **Figure 1**, about nine miles northwest of the City of Redding (see **Plate 1**). The entire reservoir is within Shasta County. Shasta Lake has 370 miles of shoreline. The reservoir controls runoff from about 6,420 square miles. The four major tributaries to Shasta Lake are the Sacramento River, McCloud River, Pit River, and Squaw Creek. There are numerous minor tributary creeks and streams.

- **Upper Sacramento River –** The upper Sacramento River drains an area of roughly 430 square miles. Its headwaters include portions of Mount Shasta and the Trinity and Klamath mountains. It flows south for approximately 40 miles before entering Shasta Lake.

- **McCloud River –** The McCloud River Basin drains an area of about 600 square miles. Its headwaters are at Colby Meadows near Bartle. The river flows southwesterly for approximately 50 miles to its terminus at Shasta Lake.

- **Pit River –** The Pit River watershed is located in northeastern California and southeastern Oregon. The north and south forks of the Pit River drain the northern portion of the watershed. The north fork of the Pit River originates at the outlet of Goose Lake and the south fork originates in the south Warner Mountains at Moon Lake, Lassen County. The Pit River is joined by the Fall River in Shasta County. There are twenty-one named tributaries, totaling about 1,050 miles of perennial stream and encompassing approximately 4,700 square miles.

- **Squaw Creek –** The Squaw Creek watershed is located east of Shasta Lake and drains 103 square miles. It flows to the southwest through generally steep terrain.

Most of the outflow from Shasta Dam travel south in the Sacramento River to the Sacramento-San Joaquin Delta. From there, flows mingled with runoff primarily from the San Joaquin River watershed and flow to the Pacific Ocean trough the San Francisco Bay. The total drainage area of the Sacramento River at the Delta is about 26,300 square miles. The average annual runoff volume to the Delta from the Sacramento River watershed is about 17.2 million acre-feet (MAF). This represents about 62 percent of the total 27.8 MAF inflow to the Delta.

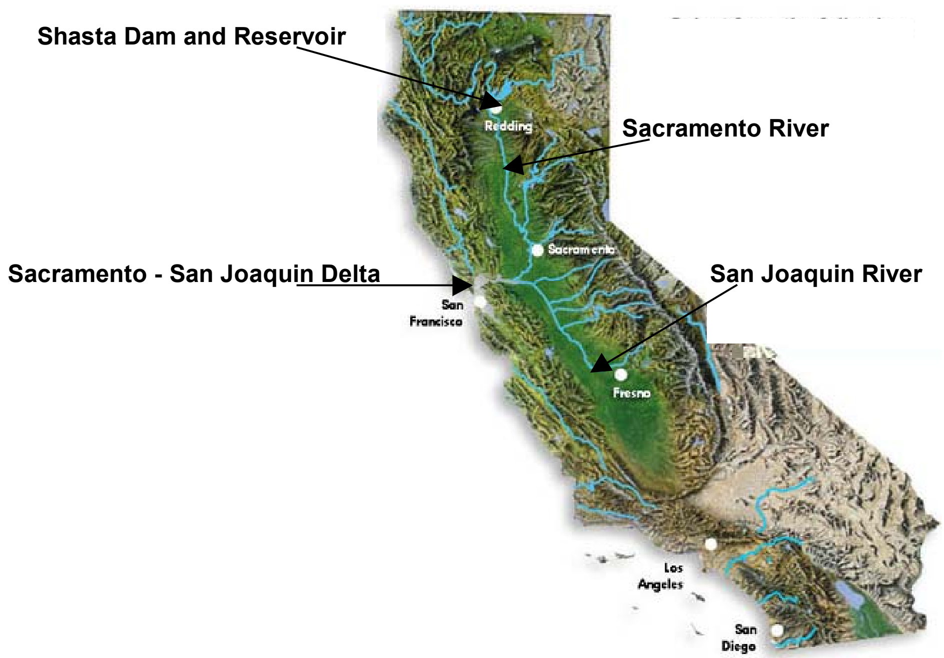

Figure 1 – Shasta Dam and Reservoir is located north of Redding on the Sacramento River

Shasta Dam was constructed during the period from September 1938 to June 1945. Storage of water in Shasta Lake began in December 1943. Gates, valves, and other items of finish work, deferred during World War II, were completed following the war and the project was placed in full operation in April of 1949. Approximately 37 miles of the Southern Pacific Railroad main line to Portland, Oregon, and 21 miles of U.S. Highway 99 (Interstate Route 5) were relocated around the reservoir during this period. When constructed, Shasta Dam was the second highest and second largest concrete dam in the world. It was exceeded only by Bolder Dam (Hoover Dam) in height and by Grand Coulee Dam in volume, but many dams now rank above it. Shasta delivers about 55 percent of the total annual water supply developed by the CVP. The Shasta Dam and Reservoir project was constructed by Reclamation as an integral element of the CVP for six purposes: irrigation water supply, municipal and industrial (M&I) water supply, flood control, hydropower generation, fish and wildlife conservation, and navigation. The project also supports vigorous water-oriented recreation at the lake. For flood control, Reclamation operates the facility in accordance with guidelines provided by the U.S. Army Corps of Engineers (Corps). All outflows from Shasta Dam flow into and through Keswick Reservoir, located about 5 miles west of Redding. Keswick Reservoir also receives inflows from Whiskeytown Reservoir on Clear Creek.

The primary study area for the Shasta Lake Water Resources Investigation is Shasta Dam and Reservoir; inflowing rivers and streams including the Sacramento River, McCloud River, Pit River, and Squaw Creek; and the Sacramento River downstream to about the Red Bluff Diversion Dam (RBDD). **Plate 1** is a map showing the primary study area within the Sacramento River Basin. **Plate 2** shows the Shasta Reservoir area.

Because of the potential influence of a modification of Shasta Dam on other programs and projects primarily in the Central Valley, the extended study area includes the Sacramento River Watershed, the Sacramento-San Joaquin and Delta, and San Joaquin and Tulare Lake basins. This area comprises one of the world's most diverse regions. California's Central Valley is home to more than four million people and a wide variety of fish and wildlife including about 180 special-status plant and animal species. The river basins provide drinking water to over two thirds of Californians. The robust economy of this region is centered on an agricultural industry that is a major source of reliable, high quality crops for the nation and the world.

STUDY AUTHORIZATION

On August 30, 1935, in the Rivers and Harbors Bill, the initial amount of Federal funds was authorized for the construction of Kennett (now Shasta) Dam. Fundamental authorization for the Shasta Lake Water Resources Investigation is under the 1980 Public Law (PL) 96-375. This law authorized the Secretary of the Interior to engage in feasibility studies relating to: (1) enlarging Shasta Dam and Reservoir, or constructing a replacement dam on the Sacramento River and (2) the use of the Sacramento River for conveying water from such enlarged dam. Another pertinent piece of legislation is contained in the Central Valley Project Improvement Act (CVPIA) of 1992 (PL 102-575).

REPORT ORGANIZATION

This Report is organized in five basic parts:

- The first is Chapter II, in which other related studies, projects, and programs are highlighted.

- The second is Chapter III, which includes a description of existing and projected future without-project water resources and related conditions.

- The third is Chapter IV, which contains a description of the fundamental problems being addressed in the investigation.

- The fourth is Chapter V, which includes the planning objectives for the investigation and the fundamental planning constraints, principles, and criteria. Also included in Chapter V is the Mission Statement for the investigation.

- The last basic part is in Chapters VI through IX, which includes information on potential concept plans, how the study is being coordinated, a description of future actions needed to complete interim documents and the final feasibility report, and a summary of findings.

CHAPTER II
RELATED STUDIES, PROJECTS, AND PROGRAMS

A number of studies, projects, and programs are underway that are important in conducting the Shasta Lake Water Resources Investigation.

U.S. BUREAU OF RECLAMATION

Central Valley Project

Shasta Dam and Reservoir are key elements of the CVP. President Franklin Roosevelt approved the CVP, including Kennet (Shasta), Friant, and Contra Costa (Delta) Divisions of the CVP, on December 2, 1935. The CVP is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the State of California's (State) 58 counties. The project includes 20 reservoirs, with a combined storage capacity of approximately 11 MAF; eight powerplants and two pump-generating plants, with a combined generation capacity of approximately 2 million kilowatts; and approximately 500 miles of major canals and aqueducts. The CVP supplies water to more than 250 long-term water contractors in the Central Valley, the Santa Clara Valley, and the San Francisco Bay Area. **Plate 3** shows the locations of major CVP facilities, rivers that are controlled or affected by the operation of CVP facilities, and the CVP service area. Shasta Reservoir delivers about 55 percent of the total annual water supply developed by the CVP.

Approximately 90 percent of CVP water is delivered to agricultural users, including prior water rights holders. The CVP has the potential to supply about 7 MAF annually to agricultural and M&I customers and for environmental purposes. Of the 7 MAF, about 6.2 MAF would be for agricultural, 0.5 MAF for urban uses, and 0.3 MAF for wildlife refuges. Municipal customers include the cities of Redding, Sacramento, Folsom, Tracy, and Fresno; most of Santa Clara County; and the northeastern portion of Contra Costa County. The CVP also provides flood control, navigation, power, recreation, and water-quality benefits.

Operational Influences

CVP operations are influenced by general operating rules, regulatory requirements, and facility-specific concerns and requirements. Inflow and release requirements are the principal elements influencing reservoir storage. Operational decisions consider not only conditions at an individual reservoir, but also downstream flow conditions and conditions at other project reservoirs. Storage space south of the Delta that can only be filled with water exported from the Delta is a major operational consideration involving the geographic distribution of water in storage. Other factors that influence the operation of CVP reservoirs include flood control requirements, carryover storage objectives, lake recreation, power production capabilities, cold water reserves, and pumping costs.

Rivers below some of the CVP dams support both resident and anadromous fisheries and recreation. While resident fisheries are slightly affected by release fluctuations, the anadromous fisheries (e.g., salmon and steelhead) are the most sensitive and are present year-round downstream of some CVP facilities. Maintaining water conditions favorable to spawning, incubation, rearing, and outmigration of the young anadromous fish is one of the main objectives. CVP operations are coordinated to anticipate and avoid streamflow fluctuations during spawning and incubation whenever possible.

The operation of the CVP is affected by several regulatory requirements and agreements. Prior to the passage of CVPIA, the operation of the CVP was affected by State Water Resources Control Board (SWRCB) Decisions 1422 and 1485, and the Coordinated Operations Agreement (COA). Decisions 1422 and 1485 identify minimum flow and water quality conditions at specified locations, which are to be maintained in part through the operation of the CVP. The COA specifies the responsibilities shared by the CVP and California's State Water Project (SWP) for meeting the requirements of D-1485. In December 1994, representatives of the State and Federal governments and urban, agricultural and environmental interests agreed to the implementation of a Bay-Delta protection plan through the SWRCB, to protect the ecosystem of the Bay-Delta Estuary. The Draft Bay-Delta Water Control Plan, released in May 1995, superseded D-1485. The coordinated operations of the CVP and SWP continue to be based on the COA.

Operation Divisions

The CVP operations are divided into eight divisions. Those north of the Delta include the Trinity, Shasta, and Sacramento River divisions. They are known collectively as the Northern CVP System. Of the operational divisions south of the Delta, the Delta, West San Joaquin, and San Felipe divisions are known collectively as the Southern CVP System. Both the Eastside and Friant divisions are operated independently of the remainder of the CVP, due to the nature of their water supplies and service areas. The Northern and Southern CVP Systems are operated as an integrated system, and demands for water and power can be met by releases from any one of several facilities. Demands in the Delta and south of the Delta can be met by the export of excess water in the Delta, which can result from releases from northern CVP reservoirs. As a result, operational decisions are based on a number of physical and hydrological factors that tend to change depending on conditions.

CVP Water Users

During development of the CVP, the United States entered into long-term contracts with many of the major water rights holders in the Central Valley. They are made of three major groups, (1) Sacramento River Settlement Contractors, (2) San Joaquin River Exchange Contractors, and (3) Water Service Contractors.

Sacramento River Settlement Contractors are contractors who, for the most part, claim water rights on the Sacramento River. With the control of the Sacramento River by Shasta Dam, these water right claimants entered into contracts with Reclamation. Most of the agreements established the quantity of water the contractors are allowed to divert from April through October without payment to Reclamation, and a supplemental CVP supply allocated by Reclamation.

San Joaquin River Exchange Contractors are contractors who receive CVP water from the Delta via the Mendota Pool. Under the Exchange Contracts, the parties agreed to not exercise their

San Joaquin River water rights in exchange for a substitute CVP water supply from the Delta. These exchanges allowed for water to be diverted from the San Joaquin River at Friant Dam under the water rights of the United States for storage at Millerton Lake.

Before construction of the CVP, many irrigators on the west side of the Sacramento Valley, on the east and west sides of the San Joaquin Valley, and in the Santa Clara Valley relied primarily on groundwater. With the completion of CVP facilities in these areas, the irrigators signed agreements with Reclamation for the delivery of CVP water as a supplemental supply. Several cities also have similar contracts for M&I supplies. They are known as CVP Water Service Contractors. CVP water service contracts are between the United States and individual water users or districts and provide for an allocated supply of CVP water to be applied for beneficial use. The purposes of a water service contract are to stimulate provisions under which a water supply is provided, to produce revenues sufficient to recover an appropriate share of capital investment, and to pay the annual operations and maintenance costs of the project.

Prior Studies of Enlarging Shasta Dam

Several studies have been conducted since the early 1960’s to assess the potential feasibility of increasing the storage space at Shasta Reservoir. The most significant occurred in the late 1970’s and early 1980’s. Evaluations to raise Shasta Dam evaluated structural modifications, environmental and related impacts, water supply and hydropower benefits, costs, and Federal interest. In November 1978, Reclamation produced for Congress an appraisal-level cost evaluation for enlarging Shasta Reservoir. Subsequent to this report, Congress directed Reclamation to engage in a feasibility study with the California Department of Water Resources (DWR) regarding the enlargement of Shasta Lake. Most studies were competed in the early 1980’s as part of PL 96-375. These studies culminated with the Final ”Wrap-Up Report”, completed in 1988. As mentioned, the basic conclusion of this report was that although enlarging Shasta Dam appeared feasible, there was a low demand for new supplies at the time.

No further action was taken on the potential project until the Mid-1990s when Reclamation again prepared an appraisal-level study and report in May 1999 to review the estimated costs for a range of enlargement options and to identify critical issues that would affect project feasibility. Three dam raises were considered in the study: 202.5 feet High Level option, 102.5 feet Intermediate Level option, and 6.5 feet Low Level option. Studies contained in the Shasta Dam and Reservoir Enlargement Appraisal Assessment concluded that raises up to 202.5 feet are technically feasible but higher raises would involve an increasing number of relocations and environmental impacts. The report recommended additional studies be conducted that focused on low-raise options.

Central Valley Project Improvement Act

The CVPIA was signed into law in October 1992 to address conflicts over water rates, irrigation land limitations, and environmental impacts of the CVP. This legislation mandates changes in the management of the CVP, particularly for the protection, restoration, and enhancement of fish and wildlife. The CVPIA also addresses the operational flexibility of the CVP and ways to expand the use of voluntary water transfers and improved water conservation. The general purposes of the CVPIA, as identified by Congress in Section 3402, include the following:

- To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California.

- To address impacts of the CVP on fish, wildlife, and associated habitats.

- To improve the operational flexibility of the CVP.

- To increase water-related benefits provided by the CVP to the State of California through expanded use of voluntary water transfers and improved water conservation.

- To contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.

- To achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agriculture, M&I, and power contractors.

The CVPIA redefined the purposes of the CVP to include protection, restoration and enhancement of fish, wildlife, and associated habitats and protection of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The CVPIA identified numerous specific measures and programs to meet the new project purpose. It also directed the Secretary of the Interior to operate the CVP consistent with these purposes. Sections of the CVPIA that are important to this study include: dedication of a portion of CVP yield to be used for environment purposes; the Anadromous Fish Restoration Program (AFRP), which included a goal of doubling natural production of anadromous fish in Central Valley rivers and streams; the Restoration Fund; urban water reliability; water transfers; refuge water supplies; restoration of the San Joaquin, Trinity, and Stanislaus rivers; and a stakeholder process.

The combined total amount of water dedicated to the environment by CVPIA suggests an annual amount of up to 1.2 MAF. This includes reallocation of the 800,000 acre-feet contained in Section 3406 (b)(2) of the law (commonly called (b)(2)), dedicated inflows to wildlife refuges of 250,000 acre-feet (called Level 2 Refuge water), and Trinity Reapportion amounting to 150,000 acre-feet. However, after accounting for system operation flexibility, the total impact of the CVPIA for CVP contractors is estimated to amount to 585,000 acre-feet annually. It is estimated that this reduced water supply has resulted in increased groundwater overdraft, fallowing of agricultural land, loss of jobs, and loss of over $100 million in annual farm income.

Implementation of the CVPIA (b)(2) provision has been a contentious process, marked by conflict between the State and Federal parties, and substantial litigation. The center of the dispute has been whether the (b)(2) water translates into an automatic reduction in exports under the water supply contracts. On January 2, 2003 Reclamation released a draft decision on the implementation of (b)(2) water. The decision incorporates parts of an earlier decision (Interiors 1999 Final Decision), modifies others, and adds new components. The intent of these changes is to simplify and clarify the accounting process for (b)(2) uses and to integrate its dedication and management with CVP operation for other CVP purposes. The decision is divided into sections to addresses calculations of yield, accounting processes, modifications of CVP operations, water banking and transfers/exchanges of water, water to meet the 1995 Bay-Delta Water Quality

Control and Endangered Species Act of 1978 (ESA) obligations, shortage criteria, and coordination.

CVP Water Supply Improvement Plan

Section 3408 (j) of the CVPIA directed the Secretary of the Interior to prepare a plan to increase the yield of the CVP. This section basically directs the Secretary to develop a least-cost plan to increase the yield of the CVP by an amount equal to that dedicated to fish and wildlife under the CVPIA. This plan is also intended to assist the State in meeting its future water needs. Further, it is to recommend appropriate cost-sharing arrangements to implement the CVP Water Supply Improvement Plan. A preliminary least-cost yield increase plan was completed by Reclamation in 1995. This plan identified cost and supply estimates for a number of new water supply and management options including groundwater storage, land fallowing, conservation and reuse, and surface storage. The plan did not, however, propose a specific CVP yield increase. Reclamation is preparing a supplement to the 1995 plan.

CVPIA Contract Renewal Process

In accordance with Section 3404(c) of the CVPIA, Reclamation is negotiating long-term water service contracts. It is anticipated that as many as 111 CVP water service contracts, located within the Central Valley, may be renewed during this negotiation process. As part of this process, Reclamation is also negotiating renewal of 55 interim water service contracts.

Red Bluff Diversion Dam Fish Passage Program

The RBDD, which is owned and operated by Reclamation, is located on the Sacramento River about 2 miles southeast of the city of Red Bluff. The 52-foot high 740-foot long dam and 3,900 acre-foot lake are elements of the CVP and designed to provide irrigation water to areas in Tehama, Glenn, and Colusa counties via the Tehama-Colusa and Corning Canals. Although a fish ladder is located on each abutment of the dam, ineffective fish passage at the dam has been identified as a contributing factor in the decline in the populations of anadromous fishes in the upper Sacramento River. Various studies and constructed test projects with a focus on reducing impacts on the anadromous while maintaining irrigation diversion capabilities at the dam have been completed. However, additional studies are ongoing.

Trinity River Restoration Plan

Trinity Dam and Lake are located about 24 miles north west of Redding. Construction of Trinity Dam was completed in 1962. The dam is an earthfill structure 538 feet high with a crest length of 2,450 feet. Trinity Lake drains an area of about 3,000 square miles and has a total capacity of nearly 2.5 MAF. The Trinity River Division of the CVP, which includes Trinity and Whiskeytown Dams, conveys water from the Trinity River to the Sacramento River Basin for export to water-deficient areas of the Central Valley.

In December 2000, the Secretary of Interior issued a ROD documenting the selection of actions necessary to restore and maintain the anadromous fishery in the Trinity River. This culminated a nearly 20-year process of detailed scientific efforts. The Trinity ROD implements a component of the CVPIA (Section 3406(b)(23)). This section is to meet Federal trust responsibilities to protect the fishery resources of the Hoopa Valley Tribe, and to meet the fishery restoration goals of PL 98-541, October 24, 1984. The ROD adopts a preferred alternative that includes restoration and perpetual maintenance of the Trinity River's fishery resources resulting in rehabilitating the river itself by restoring the attributes that produce a healthy, functioning alluvial river system. The preferred alternative reduced the average annual export of Trinity River water from 74 percent of the flow to 52 percent. The Trinity ROD is a general statement of policy regarding the issues of water flow in both the Trinity and Sacramento River mainstems. It is acknowledged to have broad effect on both rivers' ecosystems and potentially significant economic effect within the Sacramento and Trinity River basins. The major components of the selected course of action include (1) a variable annual instream flow for the Trinity River, (2) physical channel rehabilitation, (3) sediment management including the supplementation of spawning gravels, (4) watershed restoration efforts, and (5) river infrastructure improvements.

Battle Creek Restoration Project

Reclamation in partnership with the Pacific Gas and Electric Company (PG&E), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS) and the State of California Department of Fish and Game (DFG) are working to restore major reaches of Battle Creek. The Battle Creek Salmon and Steelhead Restoration Project provides for a private and public sector partnership focused on restoring the winter-run, spring-run, fall- and late-fall-run chinook salmon, and steelhead, all of which are already listed or proposed for protection by the ESA. This partnership will provide the framework for restoring one of the most important anadromous fish spawning streams in the Sacramento Valley while maintaining a pollution-free renewable energy resource for electric customers of California. Restoration actions will greatly enhance 43 miles of habitat and should increase all salmon and steelhead runs. Steelhead escapement is expected to increase the most under restored conditions. It is predicted that the adult steelhead population will increase by 5,700, which will more than double the average run to the entire Sacramento River above Red Bluff. The gain of 2,500 adult winter- and spring-run chinook salmon would also appreciably increase the total run size of these species.

Sacramento River Diversion Feasibility Study (Sacramento River Water Supply Reliability Study)

Reclamation and Placer County Water Agency are conducting the Sacramento River Diversion Feasibility Study. The purpose of the study is to develop a plan to implement the objectives of the Water Forum Agreement for the American River Watershed, which includes pursuing a water diversion project from the Sacramento River to help meet future water supply needs of the Placer-Sacramento Region and to promote ecosystem restoration along the Lower American River. The study is being conducted under provisions in Section 103 to PL 106-554.

CALIFORNIA DEPARTMENT OF WATER RESOURCES

State Water Project

The SWP was authorized in 1959 and designated to re-adjust geographical imbalances between California's water resources and water needs. The project extends from Plumas County in the north to Riverside County in the south. Completed project elements include 23 dams and reservoirs, six powerplants, 17 pumping plants, and 533 miles of aqueduct. The principal storage feature of the SWP is Lake Oroville, with a gross pool capacity of 3.5 MAF located on the Feather River about 4 miles northeast of Oroville. Water released from Oroville Dam flow though the Feather and Sacramento rivers to reach the Sacramento-San Joaquin Delta. The SWP delivers water to service areas in the Feather River Basin, San Francisco Bay area, San Joaquin Valley, Tulare Basin, and southern California. The major SWP conveyance facilities in the Central Valley include the North Bay, South Bay, and California Aqueducts. The North Bay Aqueduct diverts water from the north Delta near Cache Slough for agricultural and municipal uses in Napa and Solano counties. The South Bay and California Aqueducts carry water from the Delta to the San Francisco Bay area and to southern California, respectively. In the southern portion of the Delta, the Harvey O. Banks Delta Pumping Plant lifts water into the California Aqueduct from the Clifton Court Forebay. At 444 miles, the California Aqueduct is the State's largest and longest water conveyance system, beginning at the Banks Pumping Plant and extending to Lake Perris, south of Riverside in southern California. **Plate 3** includes a layout of major SWP facilities.

The SWP has contracted a total of 4.23 MAF for average annual delivery in the San Joaquin River, the Central Coast, and the San Francisco and South Coast areas. Of this amount, about 2.5 MAF is designated for the Southern California Transfer Area, nearly 1.36 MAF to the San Joaquin Valley, and the remaining 370,000 acre-feet to the San Francisco Bay, the Central Coast, and the Feather River areas.

SWP contracts are made up of the Feather River Settlement Contractors and SWP Contract Entitlements. The Feather River Settlement Contractors are water users who hold riparian and senior appropriative rights on the Feather River. SWP Contract Entitlements are contracts executed in the early 1960s that established the maximum annual water amount (entitlement) that each long-term contractor may request from the SWP.

California Water Plan

The State, through the DWR, prepares and publishes the California Water Plan through its Bulletin 160 series. Seven versions of the plan have been published between 1966 and 1998. A 1991 amendment to the California Water Code directs DWR to update the plan every five years. The Bulletin 160 series assesses California’s agricultural, environmental, and urban water needs and evaluates water supplies in order to quantify the gap between future water demands and supplies. A focus of the 1998 Bulletin is on water management actions that could be implemented to improve California’s water supply reliability. Estimates of existing and likely future without-project water supplies, demand, and shortages in Chapter III are based on the findings in the 1998 Bulletin.

Work is underway for the 2003 update to the plan. The update is being prepared in a highly collaborative environment with a 65-member public Advisory Committee, a 260-person Extended Review Forum, and an outside facilitation team. Key elements of the Update 2003 will include: (1) identifying water management efforts for improving water supplies and minimizing imports from other regions; (2) developing goals and management options; (3) identifying potential evaluation and selection criteria for future system modifications; and (4) identifying indicators and ongoing efforts to monitor and track progress. The 2003 California Water Plan Update will assess potential impacts and implications of global climate change on

California's water system infrastructure and future water supply, quality, and management, including short and long-term recommendations.

CALFED BAY-DELTA PROGRAM

The CALFED Bay-Delta Program is a cooperative effort among State and Federal agencies and California's environmental, urban, and agricultural communities. The Governor of California and the President initiated work on the program in 1995 to address environmental and water management problems associated with the Bay-Delta system. CALFED has taken a broad approach to addressing four problem areas: (1) water quality, (2) ecosystem quality, (3) water supply reliability, and (4) levee system integrity. Many of the problems and solutions in the Bay-Delta system are interrelated. Program implementation began following circulation of the final programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and the signing of the ROD in August 2000.

The Preferred Program Alternative (PPA) in the CALFED ROD consists of programmatic elements that set the long-term direction of the CALFED program to meet its Mission Statement[1] and objectives[2]. The PPA has several interrelated programs and includes a series of actions to execute them. Implementation of the CALFED programs depend on authorization and funding from participating State and Federal agencies. The PPA is expected to take 25 to 30 years to complete. Implementation is roughly divided into several stages, with Stage 1 lasting seven years.

CALFED Programs

The major CALFED programs consist of Conveyance, Water Transfer, Environmental Water Account, Water Use Efficiency, Water Quality, Levee System Integrity, Ecosystem Restoration and Watershed Management, and Storage.

- **Conveyance –** The Conveyance Program is aimed primarily at increasing export pumping capacity at SWP facilities in the South Delta from their current limit of 6,680 cubic foot per second (cfs) to 8,500 cfs and eventually to 10,300 cfs. Several major projects include: new fish screens at the Clifton Court Forbay and Tracy pumping plant; operable barriers to improve South

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1 **CALFED Mission Statement -** The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

2 **CALFED Objectives -** CALFED developed the following objectives:

- Provide good water quality for all beneficial uses.
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.
- Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system.
- Reduce the risk to land use and associated economic activities, water supply, infrastructure and the ecosystem from catastrophic breaching of Delta levees.

Delta water levels and quality; Tracy Fish Test Facility; Delta Cross Cannel Reoperation; Clifton Court Forbay/Tracy Pumping Plant Inter-Tie; CVP/SSWP Aqueduct Inter-Tie; and San Luis Reservoir Low Point Improvement Project.

- **Water Transfer –** Potential water transfers are being evaluated to minimize the effects of a drought. Work is continuing on promoting an effective water transfer market that protects water rights, the environment, and local economies.

- **Environmental Water Account –** The Environmental Water Account (EWA) is aimed at adding flexibility to the State's water delivery system to provide water at critical times to meet environmental needs without water supply impacts on cities, farms, and businesses. It gives water managers the tools to acquire, store, transfer, and release water strategically to respond to real-time ecosystem needs. By providing water that otherwise would not be available, the EWA helps to resolve one of the Bay-Delta's most fundamental conflicts: the competing water needs of the environment and people. The EWA buys water from willing sellers or diverts surplus water when safe for fish, then banks, stores, transfers, and releases it as needed to protect fish and to compensate water users. It has set a goal of acquiring at least 190,000 acre-feet of water each year through purchases. An environmental review process has been initiated.

- **Water Use Efficiency –** The goal of the Water Use Efficiency Program is to implement an aggressive program to make the best use of existing water supplies, including: definition of appropriate water measurement; certification of urban best management practices (BMPs); and refinement of quantifiable objectives for agricultural water use efficiency. The program supports local water conservation and recycling projects. Savings resulting from the Water Use Efficiency Program will be accomplished through incentive-based, voluntary programs.

- **Water Quality –** The focus of the Water Quality Program is to improve water quality from source to tap for Californians whose drinking water supplies come from the Bay-Delta watershed. The program includes (1) developing source improvements and drainage management programs, (2) investing in treatment technology projects, (3) developing a Bay Area Blending and Exchange Program, (4) facilitate efforts to develop alternative sources of water supply for southern California, and (5) improving dissolved oxygen conditions in the San Joaquin River.

- **Levee System Integrity –** The Levee System Integrity Program is to reduce the threat of levee failure and seawater intrusion to protect water supplies, water quality, major roadways, cities, towns, agricultural lands, and environmental and aquatic habitat primarily in the Delta. It includes funding for local reclamation districts to reconstruct Delta levees to a base level of protection, development of BMPs for beneficial reuse of dredged material, and refinement of Delta Emergency Management Plans and a Delta Risk Assessment.

- **Ecosystem Restoration and Watershed Management –** The Ecosystem Restoration Program consists of improving the ecological health of the Bay-Delta watershed through restoring and protecting habitats, ecosystem functions, and native species. This program offers funding, coordination, and technical assistance to support local watershed activities. Primary program elements include (1) an annual grant program to fund local projects in habitat restoration, fish passage, invasive species management, and environmental water quality; (2) habitat restoration in the Delta and its tributary watersheds; (3) stream flow augmentation in upstream areas through voluntary water purchases; (4) fish passage improvements through modification or removal of dams, improved bypasses, and ladders; (5) integrate flood management and ecosystem restoration; (6) support efforts to manage watersheds that affect the Bay-Delta system, develop watershed assessments and plans, implement specific watershed conservation, maintenance and restoration actions; and (7) management of the EWA.

- **Storage –** The Water Storage Program element seeks to develop additional storage capacity to help the needs of California's growing population and to provide increased system flexibility to help improve water quality and restore ecosystems. The first stage of the program consists of increasing the storage capacity at existing reservoirs and strategically located offstream sites by approximately 950,000 acre-feet and implementing major expansion of groundwater storage for an additional 0.5 to 1.0 MAF.

Surface Water Storage

The CALFED product delivery teams prepared numerous documents on all aspects of the programs. An important document in the storage program element for the Shasta Lake Water Resources Investigation is the Integrated Storage Investigation Report - Initial Surface Water Storage Screening (August 2000). Numerous potential reservoir sites were assessed and screened in the report. Of all the potential surface water sites considered, 12 were retained for more detailed evaluation. Of these 12, DWR and Reclamation were tasked to work with other CALFED agencies to take the necessary steps to pursue implementation of five on-stream and offstream projects. The five surface storage projects were subdivided into two categories, "Stage 1" and those requiring significant additional evaluation (CALFED Conditional). Stage 1 actions of the storage component of the PPA include expanding storage capacity at existing reservoirs and strategically located offstream sites amounting to approximately 950,000 acre-feet. The 5 surface water storage projects in the PPA include Enlarge Shasta, In-Delta Storage, Los Vaqueros Reservoir Enlargement, Sites Reservoir (a.k.a. NODOD), and Upper San Joaquin River Storage.

- **Enlarge Shasta –** The enlarged Shasta project in the PPA consists of expanding Shasta Reservoir by approximately 300,000 acre-feet through raising Shasta Dam 6.5 feet. The PPA identifies potential benefits such as increasing the pool of cold water available in Shasta Reservoir to maintain lower Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.

- **In-Delta Storage –** The Delta Wetlands project would convert two Delta islands comprising 11,000 acres (Webb Tract and Bacon Island) into surface storage facilities and two islands comprising 9,000 acres (Bouldin Island and Holland Tract) into managed habitat. The lead agency for this study is the DWR. The two storage islands would provide approximately 220,000 acre-feet of new storage capacity. A pre-feasibility scope review of the project was conducted by DWR and Reclamation, which concluded that the original evaluations were generally well planned. However, the project as proposed requires modifications and significant additional analyses. DWR and Reclamation are determining if any redesign or reconfiguration of the project could make it feasible for public ownership.

- **Los Vaqueros Reservoir Enlargement –** The Los Vaqueros Project consists of enlarging the 100,000 acre-foot existing reservoir up to 500,000 acre-feet. The project would help interconnect Bay Area conveyance facilities, and develop stakeholder agreement on integrated operation of water supply facilities. The primary purposes of the project would be to improve the quality and reliability of Bay Area drinking water supplies; improve Delta aquatic resources by reducing the effects of water deliveries from the Delta; provide for additional recreational opportunities in the Los Vaqueros watershed; and provide other benefits to the extent possible. The Contra Costa Water District (CCWD) is conducting pre-feasibility studies and supporting technical evaluations. The focus of the current studies are to further the alternatives analysis, environmental review, economic feasibility, public input and outreach, and operations and water quality modeling work necessary to prepare for a public advisory vote on the project in November 2003. Authority for Federal feasibility scope studies to consider the potential to enlarge Los Vaqueros was contained in Section 215 of PL 108-7 in the Fiscal Year 2003 Omnibus Appropriations. Further studies for the project under this authority will be dependent on the outcome of the November 2003 advisory vote.

- **Sites Reservoir (CALFED Conditional) –** The PPA also included a 1.9 MAF Sites Reservoir that would be located on the west side of the Sacramento River, about 60 miles northwest of Sacramento. The ROD concluded that extensive additional effort would be required before a decision to implement the project as part of CALFED could be made. As envisioned, the Sites Reservoir project would serve as an offstream storage reservoir filled primarily through pumped diversions from the Sacramento River and its tributaries during high flow periods. The lead agency for this study is the DWR. The primary benefits from the new storage would be increased reliability for water supplies for a significant portion of the Sacramento Valley, enhanced operational flexibility for managing fisheries and water quality, and improved Sacramento River diversion management. The name of the study has been changed to the North of the Delta Offstream Storage Project (NODOS). Public scoping for NODOS has been completed and planning, environmental, engineering, and related work is underway. Authority for Federal feasibility scope studies for the Sites (or NODOS) project was also contained in Section 215 of PL 108-7.

- **Upper San Joaquin River Storage (CALFED Conditional) –** The PPA also included a potential storage project on the Upper San Joaquin River. The ROD concluded that extensive additional effort would be required before a decision to implement the project as part of CALFED could be made. Reclamation, in coordination with DWR, is conducting the investigation. It includes developing a comprehensive list of water supply alternatives to support the San Joaquin Storage Investigation. This list consists of adding from 250,000 to 700,000 acre-feet of new storage in the San Joaquin watershed primarily through enlargement of Millerton Lake at Friant Dam or functionally equivalent project. This project would be designed to contribute to restoration of habitat, improve water quality for the San Joaquin River, and facilitate conjunctive management of water exchanges that improve water quality of deliveries to urban communities. Other potential benefits would include increased hydropower production and enhance flood control operation. Authority for Federal feasibility scope studies for the Upper San Joaquin River Storage Project was contained in Section 215 of PL 108-7.

U.S. ARMY CORPS OF ENGINEERS

Numerous projects, programs, and studies by the Corps influence the Sacramento River and its tributaries including Shasta Dam and Reservoir. Flood control projects range from various dams and reservoirs, hundreds of miles of levee and channel improvements, and a flood bypass system. A report specific to actions at Shasta Dam is the report on Reservoir Regulation for Flood Control, Shasta Dam and Lake, Sacramento River, California (January 1977 as supplemented). This report describes the methods of operation and prescribed regulations for flood control operation of Shasta Dam and Reservoir. In addition to operational regulations for flood control at Shasta Dam and Reservoir, other storage projects in the Sacramento River Basin prescribe flood control storage space, including Black Butte Dam on Stony Creek, Oroville Dam on the Feather River, New Bullards Bar Dam and Englebright Lake on the Yuba River, Indian Valley Dam on Cache Creek, and Folsom Dam on the American River. Within the San Joaquin River Basin, flood operation regulations are prescribed by the Corps for 16 dams and reservoirs.

One of many existing reports prepared by the Corps is the March 1999 Post-Flood Assessment. This report was completed following disastrous flooding that occurred throughout the Central Valley during January 1997. This report describes the impact of recent major floods in the Sacramento and San Joaquin River basins and includes information about the operation of major facilities of the flood control system, including Shasta Dam.

A major ongoing study in the Central Valley by the Corps and DWR that would significantly influence flood damage reduction and ecosystem restoration conditions along the Sacramento and San Joaquin rivers is the Sacramento and San Joaquin River basins Comprehensive Study (Comprehensive Study). Through the Comprehensive Study there is a potential, if approved by Congress, to significantly change the existing flood management system and help implement many of the projects proposed by CALFED.

OTHERS

There are numerous other Federal, State, and local programs and projects that influence the development of water resources projects and programs in the Central Valley of California. Following are several of note.

Phase 8

After many years of struggling to develop water quality standards for the Sacramento and San Joaquin River Delta, the Bay-Delta Accord (Accord) was signed by multiple partners in 1994. The Accord set water quality standards and required the SWRCB to determine which water users would be responsible to meet these standards. In 1995 the Board adopted the Water Quality Control Plan to implement the Accord. Phases 1 through 7 of the Accord involved the San Joaquin Valley and other issues. Phase 8, involving Sacramento Valley water users, threatened to derail the Accord through lengthy litigation concerning the determination of which entities and individuals would be responsible for meeting the water quality standards. The DWR and Reclamation, as operators of the State and Federal export projects, have claimed that certain water right holders in the Sacramento Valley must cease diversions or release water from storage to help meet water quality standards in the Delta. Sacramento Valley water users have claimed that their water use has not contributed to any water quality problems in the delta, and, as senior water right holders and water users within the watershed and counties of origin, they are not responsible for meeting these standards.

Rather than proceed with these highly adversarial proceedings, Sacramento Valley water users, DWR, Reclamation, and export water users agreed to defer the Phase 8 proceedings and instead, proceed in a more cooperative spirit to meet water supply, quality and environmental needs in areas of origin and throughout California. This cooperation is evidenced in the Sacramento Valley Water Management Agreement (Agreement). The Agreement includes four successive agreements: (1) Stay Agreement, (2) Short-Term Settlement Agreement, (3) Short-Term Project Implementation Agreements, and (4) Long-Term Agreements. The Agreement includes a process to resolve Phase 8 and related issues and a set of milestones to implement the short- and long-term projects. The Agreement also specifically identifies Sites Reservoir and Shasta Enlargement as potential long-term projects.

During the Short-Term Settlement Agreement, the active parties developed a long-term work plan and expanded program to guide implementation of the Long-Term Agreements. The Short-Term Agreement will continue until 2014 or until it is replaced by the long-term agreement. The Short-Term Agreement includes several provisions including:

- DWR and Reclamation remain obligated under SWRCB order to meet the Delta water quality standards during the term of the agreement.

- The agreement calls for unmet demands to be met in the Sacramento Valley, including 25,000 acre-feet of CVP water supplies for use along the Tehama-Colusa Canal and assurances that Feather River supplies can be utilized in the Sutter Bypass/Butte Slough region during dry years.

During development of the Short-Term Agreement, a workplan was developed. The short-term workplan identified and evaluated approximately 45 projects (i.e., projects that could be implemented within 1 to 2 years) including conjunctive management and surface storage reoperation projects. These projects will be developed to provide up to 185,000 acre-feet of capacity during critically dry, dry and below normal years. This capacity will be dedicated to two equal blocks. The first block (up to 92,500 acre-feet) will be made available for local use within the local agency boundary. If this water is not needed locally, it will be made available to the CVP and SWP at a negotiated rate. The second block of water (up to 92,500 acre-feet) will be provided to the SWP and CVP, which will be used to provide Water Quality Control Plan relief.

San Joaquin River Restoration

A major study underway in the San Joaquin River Basin is the development of a restoration plan for the San Joaquin River below Friant Dam by the Friant Water Users Authority (FWUA) and the National Resources Defense Council (NRDC). As part of this work, the FWUA and NRDC have been considering water supply options that could be developed to provide water for restoration needs.

Common Assumptions

Efforts are underway primarily by DWR and Reclamation to identify a series of Common Assumptions for use in developing each of the CALFED storage projects. The Common Assumptions would primarily be used to develop Without-Project Conditions, which is a critical element in the plan formulation process. The Common Assumptions are to establish recognized baseline conditions including, at minimum: (1) period of analysis; (2) evaluation levels (i.e., 2001 for existing conditions and 2020 for future conditions); (3) water supply demands; (4) water supply system facilities; (5) regulatory standards, including minimum flow and temperature requirements; (6) system operation criteria; and (7) likely foreseeable actions.

The primary planning analytical tool being used for establishing baseline assumptions for water supply budgeting is the California Water Allocation and Reservoir Operations Model (CALSIM-II). This mathematical model is also used for studying the water supply impacts of various potential alternate system operations and project modifications.

CHAPTER III
WITHOUT-PROJECT CONDITIONS

One of the most important elements of any water resource evaluation is defining the scope of problems needing to be solved and opportunities to be addressed. Significant in this process is defining existing resource conditions and how those conditions may change in the future. The magnitude of this change not only influences the scope of the problems, needs, and opportunities, but the extent of related resources that could be influenced by possible actions to address them. Accordingly, presented below is a brief assessment of existing and estimated future without-project conditions in the primary and extended study area. Additional information is provided in Appendix A (Supplemental Information for Existing Conditions). This information will continue to be developed as the feasibility study progresses.

EXISTING CONDITIONS

Shasta Dam and Reservoir Project

Existing Water Control Facilities

Shasta Dam is a curved, gravity-type, concrete structure 533 feet high above the stream-bed with a total height above the foundation of 602 feet. Lake Shasta has a storage capacity and water surface area at gross pool of 4,552,000 acre-feet and 29,600 acres, respectively. The seasonal flood control storage space in Shasta is 1.3 MAF. Shasta Dam has a crest width of about 41 feet and a length of 3,460 feet. The Shasta Powerplant consists of five main generating units and 2 station service units with a combined capacity of 652,000 kilowatts. **Table 1** summarizes the major pertinent data and features of Shasta Dam and Reservoir. **Plates 4 and 5** show several elevation, section, and plan views of Shasta Dam and Powerplant. These drawings were prepared prior to the construction of the existing temperature control facilities on the upstream face of the dam. **Plate 6** shows the relationship between reservoir surface area and storage capacity at various water surface elevations**.**

Keswick Dam is about 9 miles downstream from Shasta Dam and, in addition to regulating the outflow from the dam, controls the runoff from an additional 45 square-miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has four 50- by 50-foot fixed wheel gates with a combined discharge capacity of 248,000 cfs at full or gross pool elevation (587 feet). The storage capacity below the top of the spillway gates at gross pool is 23,800 acre-feet. The power plant has a nameplate generating capacity of 75,000 kilowatts and can pass about 15,000 cfs at gross pool.

The existing temperature control device (TCD) at Shasta was constructed between 1996 and 1998. It is a multi-level water intake structure located on the upstream face of the dam. The TCD allows operators to draw water from the top of the reservoir during the winter and spring when the surface water temperatures are cool, and from deeper in the reservoir in the summer and fall when the surface water is warm. It also improves oxygen and sediment levels in the downstream river water. The TCD helps Reclamation fulfill contractual obligations for both water delivery and power generation while benefiting fish that require cooler water temperatures, such as salmon.

TABLE 1
PERTINENT DATA – SHASTA DAM AND RESERVOIR

GENERAL			
Drainage Areas (excluding Goose Lake Basin)		**Mean Annual Runoff (1908-1974)**	
Sacramento R. at Shasta Dam	6,421 sq-mi	Sacramento R. at Shasta Dam	5,737,000 ac-ft
Sacramento R. at Keswick	6,468 sq-mi	Sacramento R. near Red Bluff	8,421,000 ac-ft
Sacramento R. above Bend		Sacramento R. at Ord Ferry	9,812,000 ac-ft
Bridge near Red Bluff	8,900 sq-mi	**Maximum Flows of Record (1903-1976)**	
Sacramento R. near Ord Ferry	12,250 sq-mi	Sacramento R. at Shasta Lake	
Pit R. at Big Bend		16 Jan 1974	216,000 cfs
	4,710 sq-mi	Sacramento R. near Red Bluff	
McCloud R. above Shasta Lake	604 sq-mi	28 Feb 1940	291,000 cfs
Sacramento R. at Delta	425 sq-mi	Sacramento R. at Ord Ferry	
		28 Feb 1940	370,000 cfs
SHASTA DAM AND LAKE			
Shasta Dam (concrete gravity)		**Shasta Lake**	
Crest elevation	1077.5 ft	Elevations msl	
Freeboard above gross pool	9.5 ft	Gross pool	1067.0 ft
Height above foundations	602 ft	Minimum operating level	840.0 ft
Height above streambed	487 ft	Taking line	Irregular
Length of crest	3500 ft	Area	
Width of crest	30 ft	Minimum operating level	6,700 acres
Slope, upstream	Vertical	Gross pool	29,500 acres
Slope, downstream	1 on 0.8	Taking line	90,000 acres
Volume	8,430,000 cu yd	Storage capacity	
Normal tailwater elevation	585 ft	Minimum operating level	587,000 ac-ft
Spillway (gated ogee)		Gross pool	4,552,000 ac-ft
Crest length		**Shasta Power Plant**	
Gross	360 ft	Main units	
Net	330 ft	5 turbines, Francis type,	
Crest gates (drum type)		total capacity	515,000 hp
Number and size	3 @ 110' x 28'	5 generators, 125,000 kw each	
Top elevation when lowered	1037.0 ft	total capacity	625,000 kw
Top elevation when raised	1065.0 ft	Station units	
Discharge capacity at pool elevation 1065 ft	186,000 cfs	2 generators, 2,000 kw each total capacity	4,000 kw
Flashboard gates		Elevation centerline turbines	586 ft
Number and size	3 @ 110' x 2'	Maximum tailwater elevation	632.5 ft
Top elevation when lowered	1067.0 ft	Total discharge capacity at pool	
Bottom elevation when raised	1069.5 ft	elevation 1065 ft	14,500 cfs
		Total discharge capacity at pool	
Outlets		elevation 827.7 ft	16,000 cfs
River outlets (102 in. dia. Conduit			
with 96 in. dia. Wheel type gate)			
4 with invert elevation	737.75 ft		
8 with invert elevation	837.75 ft		
6 with invert elevation	937.75 ft		
Capacity at elevation 1065 ft	81,800 cfs		
Capacity at elevation 827.7 ft	12,200 cfs		
Power outlets (15' steel penstocks)			
5 with invert elev. of intake	807.5 ft		
KESWICK DAM AND RESERVOIR			
Keswick Dam (concrete gravity)		**Keswick Reservoir**	
Crest elevation	595.5 ft	Elevation msl	
Freeboard above maximum		Maximum operating level	587.0 ft
operating level	8.5 ft	Minimum operating level	574.0 ft
Height of dam above foundation	159 ft	Area at maximum operating level	643 acres
Height of dam above streambed	119 ft	Storage capacity	
Length of crest	1046 ft	At maximum operating level	23,800 ac-ft
Width of crest	20 ft	At minimum operating level	16,300 ac-ft
Volume	197,000 cu-yd	**Keswick Power Plant**	
Normal tailwater elevation	487 ft	Generator capacity, 3 units	75,000 kw
Spillway (gated ogee)			
Crest length			
Net	200 ft		
Crest gates (fixed wheel)			
Number and size	4 @ 50' x 50'		
Discharge capacity at pool elevation 587 ft	248,000 cfs		

Recreation Facilities

The Whiskeytown-Shasta-Trinity National Recreation Area was established by Act of Congress in November 1965. The area comprises three separate units: Whiskeytown Lake, Shasta Lake, and Clair Engle-Lewiston Lakes. The Shasta Unit and the Clair Engle-Lewiston Unit are within the Shasta-Trinity National Forest and are administered by the U.S. Forest Service (FS). The Whiskeytown Unit is administered by the National Park Service. Facilities provided by the FS at Shasta Lake include twenty-nine campgrounds, four boat-launching ramps and two beach and picnic areas. In addition to the FS facilities, about eighteen resorts and marinas are operating under permit within the Shasta Lake Unit. Facilities provided by these permit-holders include rental housing, stores, snack bars, restaurants, excursion boats, boat-dock service and rental, camping areas and boat-launching ramps. A map showing locations of the major recreation facilities in the Shasta Unit of the Whiskeytown-Shasta Trinity National Recreation area are shown on **Plate 7**.

Major Reservoir Area Infrastructure

An inventory of infrastructure in the Shasta Reservoir area was conducted to identify features that could be subject to modification or relocation if Shasta Dam were raised up to 30 feet. The inventory was conducted from the existing gross pool elevation of 1,067 feet msl (1,070 feet under NAVD 1988 datum) to 1,097 feet msl. Over four hundred items were included in the infrastructure inventory, as summarized in **Table 2**.

TABLE 2
SUMMARY OF FACILITIES FROM EXISTING GROSS POOL TO ELEVATION 1,100 FEET

Facilities	Number
Buildings	197
Bridges	22
Dams	2
Paved Road Segments	86
Unpaved Road Segments	53
Parking Areas	16
Railroad Segments	1
Power Towers	3
Miscellaneous Objects	23
Total Items	***403***

At least one-fourth of the buildings potentially affected are homes or cabins, more than one-third are associated with private resorts or marinas, and an estimated ten percent are associated with FS facilities such as campgrounds, boat ramps, and stations. Some businesses and community buildings would also be potentially affected in Lakeshore. Ten of the twenty-two bridges in the reservoir area carry the Union Pacific Railroad; two of the bridges are on Interstate 5; one of the bridges (Pit River Bridge) carries both Interstate 5 and the Union Pacific Railroad; three of the bridges are maintained by Shasta County; and six of the bridges are maintained by the FS. Not all of the twenty-two bridges identified in the inventory would need to be relocated. Of the almost thirty campgrounds, half are either shoreline campsites or boat camps with no significant infrastructure. The developed campgrounds would be impacted by various amounts with a 30-foot raise in the reservoir.

The most significant pieces of infrastructure that would be affected by a raise of 30 feet are:

- The Pit River Bridge (Interstate 5 and Union Pacific Railroad),
- The Union Pacific Railroad between tunnels 1 and 2 (0.6 miles south of the Pit River Bridge),
- The Interstate 5 Bridge over the Sacramento River in the Lakeshore/Antlers area (and approximately 2,000 feet of Interstate 5 at Lakeshore, just north of the bridge),
- Several homes in the communities of Lakeshore and Sugarloaf, and
- The Pit 7 Dam (owned by PG&E).

Plate 8 shows a plan and profile view of the Pit River Bridge. The Pit River Bridge is the most significant structure within the inventory range. The Shasta Reservoir Area Inventory Office Report is included as Appendix B.

Physical Environment

Topography

Shasta Dam and Reservoir are located on the northern edge of California's Central Valley, which is almost completely enclosed by mountains and has only one outlet, through the San Francisco Bay to the Pacific Ocean. The valley is nearly 500 miles long and averages 120 miles in width. The Central Valley is drained by the Sacramento River in the northern portion and the San Joaquin River and Tulare Lake tributary streams in the southern portion.

The major tributary drainages above Shasta Dam, the Sacramento, McCloud, and Pit rivers, and several smaller drainages, originate in the east and flow generally westward into Shasta Lake. Downstream from the dam, the Sacramento River travels south to the Delta, picking up additional flows from numerous tributaries including Cottonwood Creek, Stony Creek, the Feather and American rivers, and others. The Sacramento River Basin covers approximately 27,000 square miles and is about 240 miles long and up to 150 miles wide.

Ground surface elevations in the northern portion of the Sacramento Valley range from above14,000 feet at Mount Shasta in the headwaters of the Sacramento River to approximately 1,070 feet at Shasta Lake. About 65 percent of the mountainous area within this range lies below 4,000 feet in elevation and 97 percent below 7,000 feet in elevation. Other mountain areas bordering the valley reach elevations higher than 10,000 feet. In the southern portion of the Sacrament River Basin, the Sacramento Valley floor is relatively flat.

Geology

The geologic provinces composing the Sacramento River region include the Klamath Mountains, the Coast Ranges, the Cascade/Modoc Plateau, the Sierra Nevada, and the Central Valley. Shasta Lake is located within the Klamath Mountain geomorphic province in the north end of the Sacramento Valley. The Klamath Mountain province is considered to be a northern extension of the Sierra Nevada. It consists of rugged topography with prominent peaks and ridges. The drainage of this province is primarily through the Klamath and the upper Sacramento rivers. Rocks include pre-Cretaceous metamorphic, abundant serpentine, and granitics.

The Central Valley province (also referred to as the Great Valley) is a large, asymmetrical, northwestwardly trending, structural trough formed between the uplands of the California Coast Ranges to the west and the Sierra Nevada to the east. This trough has been filled with a tremendously thick sequence of sediments ranging in age from Jurassic to Recent.

Soils

The soils of the Sacramento River Basin are divided into four physiographic groups: upland soils, terrace soils, valley land soils, and valley basin soils. Upland soils are prevalent in the hills and mountains of the region and are composed mainly of sedimentary sandstones, shales and conglomerates of igneous rocks. Terrace and upland soils are predominant between Redding and Red Bluff, however, valley land soils border the Sacramento River through this area. Valley land and valley basin land soils occupy most of the Sacramento Valley floor south of Red Bluff. Valley land soils consist of deep alluvial and aeolian soils that make up some of the best agricultural land in the State. The valley floor was once covered by an inland sea and soils were formed by deposits of marine silt followed by mild uplifting earth movements. After the main body of water disappeared, the Sacramento River began eroding and redepositing silt and sand in new alluvial fans.

Geomorphology

The geomorphology of the Sacramento River is a product of several factors: the geology of the Sacramento Valley, hydrology and climate, vegetation, and human activity. Large flood events drive lateral channel migration and remove large flow impediments. Riparian vegetation stabilizes stream banks and reduces water velocities, inducing deposition of eroded sediment. In the past, a balance existed between erosion and deposition along the Sacramento River. However, the construction of dams, levees, and water projects has altered stream flow and other hydraulic characteristics of the Sacramento River. In some areas, human-induced changes have stabilized and contained the river, while in other reaches the loss of riparian vegetation has reduced sediment deposition and led to increased erosion.

The upper Sacramento River between Shasta Lake and Red Bluff is bounded and underlain by resistant volcanic and sedimentary deposits that confine the river, resulting in a relatively stable river course. This reach of river is characterized by steep vertical banks and the river is primarily confined to its channel with limited overbank floodplain areas. There is limited meander of the river above Red Bluff. Downstream from Red Bluff, the Sacramento River is active and sinuous, meandering across alluvial deposits within a wide meander belt. Geologic outcroppings and man-made structures, such as bridges and levees, act as local hydraulic controls along the river. Bank protection, consisting primarily of rock riprap, has been placed along various sections of the Sacramento River to prevent erosion and river meandering.

Sedimentation and Erosion

Sedimentation and erosion are natural processes throughout the primary and extended study areas. These processes have been affected by a number of factors, including hydraulic mining; construction of dams, reservoirs, and channel modifications; and agriculture and urban activities.

The watershed above Shasta Lake is generally well forested and erosion is not excessive. However, landslides are relatively common as much of the area is steep. Slides and sheetwash supply debris and bedload sediments to the tributary streams of Shasta Lake. Many of the reservoir tributaries are well-balanced systems where flows and bedload are in dynamic equilibrium.

Shasta and Keswick Dams effect sediment transport as they block the sediments that would normally have been transported from the upper Sacramento River Basin. The result has been a net loss of coarse sediment in the Sacramento River below Keswick Dam that has negatively impacted spawning gravels. In alluvial river sections, bank erosion and sediment deposition cause migrations of the river channel that are extremely important in maintaining instream and riparian habitats, but can also cause loss of agricultural lands and damage to roads and other structures. In the Sacramento River, these processes are most important in the major alluvial section of the river, which begins downstream from the RBDD. The river channel in the Keswick to RBDD reach is more constrained by erosion-resistant volcanic and sedimentary formations and, therefore, is more stable.

Hydrology

The Sacramento River Basin contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Delta north to the Oregon border. Hot, dry summers and mild winters characterize the valley floor. Total annual precipitation at higher elevations averages between 60 and 70 inches and is as high as 95 inches in the northern Sierra Nevada and the Cascade Range. Precipitation on the valley floor occurs mostly as rain, and yearly totals range from 20 inches in the northern end of the valley to about 15 inches at the Delta. Average annual precipitation throughout the Sacramento River Basin is 36 inches. The most intensive runoff occurs in the upper watershed of the Sacramento River above Lake Shasta and on the rivers originating on the west slope of the Sierra Nevada. These watersheds produce an annual average of 1,000 to more than 2,000 acre-feet of runoff per square mile.

The Sacramento River contributes the majority of Delta inflow. Unimpaired flow from the four major rivers in the Sacramento River Basin (Sacramento, Feather, Yuba, and American rivers) averaged 21.2 MAF and ranged from about 5 to 38 MAF during the 1906-1996 period. Of this, the Sacramento River (at Red Bluff) averaged 8.4 MAF (including Trinity River imports, described below), the Feather River averaged 4.5 MAF, the Yuba River averaged 2.4 MAF, and the American River averaged 2.6 MAF.

Mean monthly inflows, outflows, and storages at Shasta Reservoir are shown in **Table 3**. As can be seen, the highest average monthly inflow period for Shasta is January through March. Winter and early spring inflows are stored for later release during the summer irrigation season.

Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through CVP facilities, as shown in **Figure 2**. Historically, an average annual quantity of 1.27 MAF of water has been exported. This annual quantity is approximately 17 percent of the flows measured in the Sacramento River at Keswick Dam. As mentioned, however, Trinity River diversions to the Sacramento River are to be reduced as part of the December 2002 ROD to allow more inflows to remain in the Trinity River for fish restoration purposes.

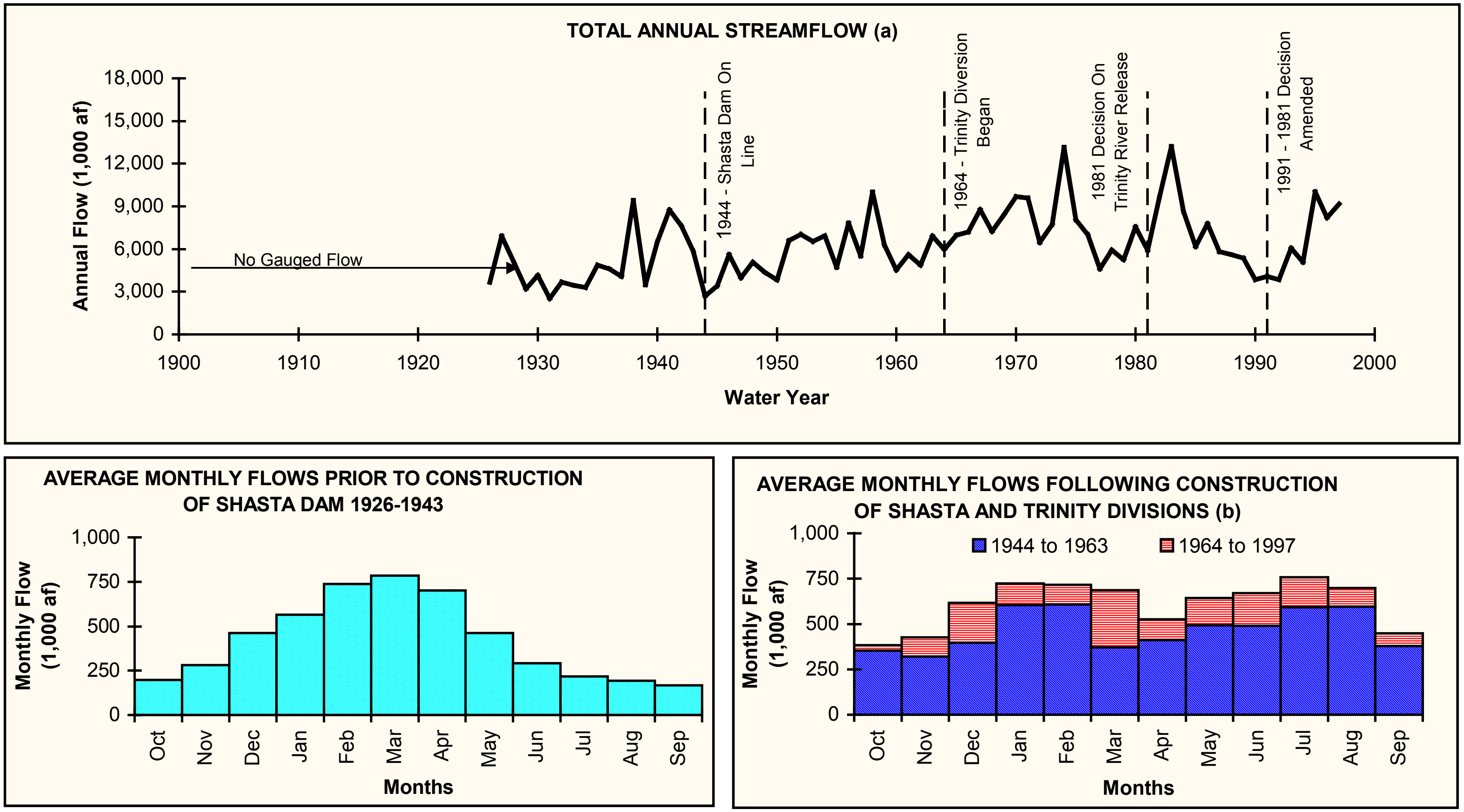
TABLE 3
MEAN MONTHLY INFLOW TO SHASTA RESERVOIR

Month	Inflow [1] (1,000 Acre-Feet)	Outflow [2] (1,000 Acre-Feet)	Shasta Storage [3] (1,000 Acre-Feet)
January	799	587	3,131
February	836	628	3,355
March	889	511	3,719
April	693	421	3,961
May	537	524	3,948
June	339	536	3,720
July	247	615	3,326
August	223	571	2,966
September	220	377	2,809
October	263	301	2,775
November	365	331	2,801
December	585	465	2,906
Total	***5,991***	***5,868***	***NA***
Average	***499***	***489***	***3,285***

Notes:
1. Computed data based on a period from 1944 to 2002.
2. Recorded data based on a period from 1944 to 2002.
3. Shasta storage data computed based on a period from 1953 to 2002.

Flood Control

A number of flood management projects along the Sacramento River affect the flow and operation of facilities, including dams and reservoirs, levees, and weirs. Major reservoirs in the Sacramento River watershed and flood control storage space include Folsom Reservoir on the American River, Lake Oroville on the Feather River, Black Butte Reservoir on Stony Creek, and Shasta Reservoir. Other major flood management system facilities include five weirs located along the Sacramento River to divert part of the floodflows to the overflow basins and bypasses (Butte Basin, Sutter Bypass, and Yolo Bypass). The weirs allow high Sacramento River flow to enter the basin and bypass the system. The weirs were designed to begin operation in a certain order: Tisdale Weir, Colusa Weir, Fremont Weir, Moulton Weir, and Sacramento Weir.



Notes
(a) First full year of stream flow data for station 11370500 was 1939. Data for 1926-1963 are from Station 1136950.
(b) Upper portion of bar represents incremental increase in average monthly flows since 1964 water year, when releases through Spring Creek Powerplant.

Figure 2 – Historical streamflow in the Sacramento River below Keswick Dam.

The flood management system of the San Joaquin River Basin includes levees along the lower portions of Ash and Berenda sloughs; Bear Creek; Fresno and Stanislaus rivers; and leveed sections along the San Joaquin River. The Chowchilla Canal Bypass diverts San Joaquin River flow excess and sends it to the Eastside Bypass. In addition to the Chowchilla Canal Bypass, the Eastside Bypass intercepts flows from minor tributaries and rejoins the San Joaquin River between Fremont Ford and Bear Creek. The San Joaquin River levee and diversion system is not designed to contain the objective release from each of the project reservoirs simultaneously.

The primary non-Federal sponsor for flood control projects in both the Sacramento and San Joaquin River basins is the Reclamation Board of the State of California. The Reclamation Board has signed onto the assurances of operating and maintaining the Federal project under the authority of the Flood Control Act of 1944. The Reclamation Board has local agreements with the DWR, levee districts, reclamation districts, and other entities. These local agreements share operation and maintenance requirements with the Reclamation Board. Because reclamation districts and other local entities do the actual maintenance and operation for sections of the flood control project, maintenance practices vary from almost no maintenance to outstanding maintenance. The quality of maintenance normally depends on the funding availability to the maintaining entity, which varies widely.

Maintaining the flood management system levees and channels is difficult due to the erosive nature of the flood flows that the current system configuration produces, and due to expensive, environmental mitigation when bank protection is required. The system is tightly leveed in many locations and the levees must be continually protected from erosion. The most common material used is rock riprap, which effectively prevents erosion but negatively impacts riparian habitat. Mitigation costs for new flood control projects and improvements have constantly increased over the past decades due to environmental awareness.

The current regulation of Shasta Dam for flood control requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible (1) a flow of 79,000 cfs at the tailwater of Keswick Dam and (2) a stage of 39.2 feet at the Sacramento River at Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs). **Plates 9 and 10** show peak flow-frequency relationships at both Keswick and Bend Bridge. A storage space of up to 1.3 MAF below gross pool elevation of 1,067 feet is also kept available for flood control purposes in the reservoir in accordance with the Flood Control Diagram (see **Plate 11**), as prescribed by the Corps. Under the diagram, flood control storage space increases from zero on October 1 to 1.3 MAF (elevation 1,018.55) on December 1 and is maintained until December 23. From December 23 to June 15, the required flood control space varies according to parameters based on the accumulation of seasonal inflow. This variable space allows for the storage of water for conservation purposes, unless it is required for flood control purposes based upon basin wetness parameters and the level of seasonal inflow. Daily flood control operation consists of determining the required flood storage space reservation and scheduling releases in accordance with flood operating criteria.

Flood control operations of Shasta Dam require forecasting of flood runoff both above and below the dam. Rapidly changing inflows are continually monitored, and the forecasts of the various inflows are adjusted as required. The time of streamflow travel from Shasta Dam to Bend Bridge is about 9 to 10 hours under higher flow conditions. The timing of peak reservoir inflows and peak inflows from tributaries downstream from the dam can complicate release operations. The large size of the flood control pool at Shasta Reservoir can prolong flood release operations for many weeks as operators vacate the pool before the next storm event.

As indicated, a goal of the existing operation is to have in excess of the required flood control space vacant in the flood season and then fill the pool to the maximum extent possible for water supply and other needs in the remainder of the year. **Plate 12** is a plot showing the historical monthly storage in Shasta Reservoir for the period of 1953 through 2002. As can be seen, in most years Shasta Reservoir has been able to fill following the flood season drawdown.

Table 4 shows the total annual inflows to Shasta Reservoir for the period 1945 through 2002. Also shown is the end of water year (September 30) storage and those years in which a release was needed from Shasta Dam for flood control. Releases for flood control could either be in the fall to reach the prescribed vacant flood space beginning in early October or to evacuate space during or after a storm event.

Figure 3 shows the estimated frequency (percent exceedance) of storage in Shasta Reservoir for the end of September. As can be seen, the average storage in the reservoir (50 percent exceedence) under existing conditions prior to the beginning of flood control operations is about 2.7 MAF. The frequency distribution graph also shows that in about 80 percent of the years, the end of September stage is greater than about 1.9 MAF, and 3.3 MAF in about 20 percent of the years.

As mentioned, the estimated safe channel carrying capacity of the Sacramento River downstream from Keswick through Redding is 79,000 cfs. Shasta Dam and Reservoir can control outflows from Keswick to that value from about the 1.3 chance in 100 to 1.0 chance in 100 in any one year (see **Plate 9**) if it is operated precisely according to the Flood Control Manual. For flood events rarer than about the 1.0 chance in 100 in any one year, inflows to Shasta would exceed the ability of the reservoir to store the inflow volume and maintain the 79,000 cfs channel capacity. Under these circumstances, the outflows from the dam would need to be increased to prevent uncontrolled conditions (see **Plate 9**).

Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries enter the Sacramento River downstream from the dam. Stream gages have been added to the major uncontrolled tributaries entering downstream from Shasta Lake (Cow, Battle, Cottonwood, and Thomes creeks). To a limited extent, the operators of Shasta Dam can adjust releases containing these uncontrolled flows to try to reduce downstream peak flows. Accordingly, the influence of Shasta's operation on reducing peak flood flows diminishes downstream on the Sacramento River.

TABLE 4
SHASTA DAM AND RESERVOIR FLOOD CONTROL RELEASES

Water Year	Total Annual Inflow (1,000 Ac-Ft)	End of September Storage (1,000 Ac-Ft)	Flood Release? Yes	Flood Release? No	Reason	Water Year	Total Annual Inflow (1,000 Ac-Ft)	End of September Storage (1,000 Ac-Ft)	Flood Release? Yes	Flood Release? No	Reason
1945	4,858			X	Initial Filling	1974	10,796	3,658	X		
1946	5,905			X		1975	6,405	3,570	X		
1947	3,907			X		1976	3,611	1,295	X		Nov/Dec Drawdown
1948	5,416			X		1977	2,628	631		X	
1949	4,368			X		1978	7,837	3,428	X		
1950	4,134			X		1979	4,022	3,141		X	
1951	6,316			X		1980	6,415	3,321	X		
1952	7,786			X		1981	4,103	2,480	X		
1953	6,541	3,300	X			1982	9,013	3,486	X		
1954	6,540	3,059	X			1983	10,794	3,617	X		
1955	4,112	2,455		X		1984	6,667	3,240	X		
1956	8,831	3,569	X			1985	3,971	1,978	X		Nov/Dec Drawdown
1957	5,369	3,485	X			1986	7,546	3,211	X		
1958	9,700	3,473	X			1987	3,944	2,108		X	
1959	5,086	2,504	X			1988	3,931	1,586		X	
1960	4,733	2,756		X		1989	4,745	2,096		X	
1961	5,073	2,333	X			1990	3,616	1,637		X	
1962	5,261	2,908	X			1991	3,051	1,340		X	
1963	7,002	3,242	X			1992	3,622	1,683		X	
1964	3,905	2,202		X		1993	6,825	3,102	X		
1965	6,983	3,612	X			1994	3,087	2,102		X	
1966	5,299	3,263	X			1995	9,638	3,136	X		
1967	7,404	3,506	X			1996	6,846	3,089	X		
1968	4,772	2,670	X			1997	7,424	2,308	X		
1969	7,667	3,528	X			1998	10,294	3,441	X		
1970	7,901	3,440	X			1999	7,196	3,328	X		
1971	7,327	3,275	X			2000	6,839	2,985	X		
1972	5,078	3,267	X			2001	4,141	2,200		X	
1973	6,167	3,317	X			2002	5,052	2,558		X	
Average							***5,991***	***2,430***			
Total - In Period (1945-2002)									***36***	***22***	
Total - Outside Filling Period (1953-2002)									***36***	***14***	
Percent of Years (Outside Filling Period)									***72***	***28***	

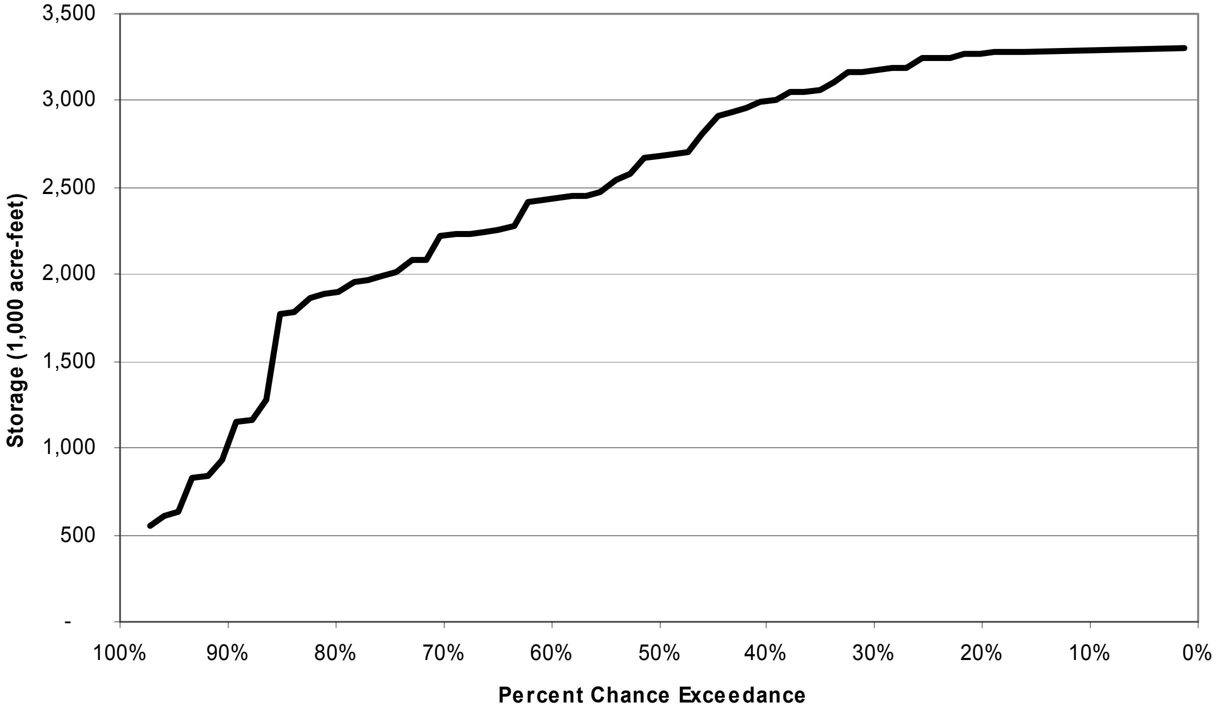


Figure 3 – Estimated Frequency (Percent Chance Exceedance) of Storage at the End of September in Shasta Reservoir with 2000 Level Demands and D-1641 Requirements

Water Quality

The SWRCB and the regional water quality control boards largely determine objectives for water quality in California's surface waters. The project area lies entirely within the region under jurisdiction of the Central Valley Regional Water Quality Control Board (CVRWQCB). The water quality objectives for a particular reservoir or river reach are affected by its beneficial uses, which are determined by the CVRWQCB. The water quality must adequately protect the beneficial uses. The beneficial uses for Shasta Lake and its tributaries, and the reach of the Sacramento River between Shasta Dam and the Colusa Drain (which includes Keswick Reservoir and the river between Keswick Dam and the RBDD) are provided in **Table 5**.

Water quality in the project area generally supports the beneficial uses of the area's rivers and reservoirs. However, impaired water quality conditions have been found for specific waters of the project area in the recent past and some of these impaired conditions persist. The principal water quality issues for the project area include water temperatures in the Sacramento River between Keswick Dam and the RBDD, turbidity in Shasta Lake, and acid mine drainage and associated heavy metal contamination from the Spring Creek drainage and other abandoned mining sites. Elevated pesticide levels have been found at some sites in the Sacramento River Valley for a number of years, but these sites are downstream from Red Bluff. Storm water runoff from Redding and other urban areas likely flushes contaminants into the Sacramento River, but the volume of flow in the river generally provides sufficient dilution to prevent excessive concentrations in the river. The City of Redding is working toward compliance under Phase II of the National Pollution Discharge Elimination System (NPDES).

TABLE 5
BENEFICIAL USES FOR THE SURFACE WATERS IN THE PROJECT AREA

Beneficial Use	Pit River (Hat Creek to Shasta Lake)	McCloud River	Sacramento River, Box Canyon Dam to Shasta Lake	Shasta Lake	Sacramento River (Shasta Dam to Colusa Drain)
Municipal & domestic supply (drinking water)	E*	E		E	E
Agriculture, irrigation	E		E	E	E
Agriculture, stock watering	E		E		E
Industry, Service Supply					E
Industry, Power	E	E		E	E
Recreation, contact	E	E	E	E	E
Recreation, whitewater	E	P	P		E
Recreation, noncontact	E	E	E	E	E
Freshwater habitat, warm	P			E	P
Freshwater habitat, cold	E	E	E	E	E
Migration, warm					E
Migration, cold					E
Spawning, warm	E			E	E
Spawning, cold	E	E	E	E	E
Wildlife habitat	E	E	E	E	E
Navigation					E
** E refers to an existing beneficial use, P refers to a potential beneficial use*					

Air Quality

The northern half of the Central Valley is located in the Sacramento Valley Air Basin (SVAB). The Coast Range, the Sierra Nevada Range, the Cascade Mountains, and the San Joaquin Valley Basin bound the basin. Marine winds enter the valley at the Carquinez Straits and head eastward until deflected north into the Sacramento Valley and south into the San Joaquin Valley. A combination of air contaminants, meteorological conditions, and the topographic configuration of the valley affect air quality throughout the Sacramento Valley Basin. Most of the air pollutants in the study area may be associated with either urban or agricultural land uses.

During the summer, the Pacific high-pressure systems can create inversion layers in the lower elevations that prevent the vertical dispersion of air. As a result, air pollutants can become concentrated during the summer, lowering air quality. During the winter, when the Pacific high-pressure system moves south, stormy, rainy weather intermittently dominates the region. Prevailing winter winds from the southeast disperse pollutants, often resulting in clear, sunny weather and better air quality over most of the region. Much of the SVAB is designated as a non-attainment area with respect to the national and State ozone (O_3) and particulate matter (PM_{10}) standards, and the urban Sacramento and Maryville/Yuba City area are designated as non attainment for national and State carbon monoxide (CO) standards.

The relatively low residential density of Shasta County's rural and suburban residential areas contributes to an auto-dependent life-style that affects quality. Pollution from mobile sources, such as cars and trucks, represents 43 percent of hydrocarbons emissions, 57 percent of nitrogen oxide (NO) emissions, 59 percent of reactive organic gases and 82 percent of CO emissions in typical urban areas of Shasta County (Shasta County General Plan). There are many other sources of air pollution in the study area (i.e., residential, agriculture, and forest management burn practices, imported pollutants from lower Sacramento Valley, unpaved roads, etc.).

Noise

Noise levels in densely populated areas of the State are influenced predominantly by the presence of limited-access highways carrying extremely high volumes of traffic, particularly heavy trucks. Noise in rural areas in which traffic generally is low to moderate is measured at considerably lower decibels. Noise at Shasta Lake is affected by the presence of boats for water skiers and personal watercraft.

Biological Environment

Biological resources in the region are resultant of a wealth and diversity of climatic and vegetative associations within and adjacent to the project area. Influences from the coastal mountains, southern Cascades, northern Sierra Nevada, Great Basin and Central Valley provide for a unique mix of biota.

Much of the area, especially that within the Central Valley, has been modified by past and present land uses. Prior to human settlement, this region was dominated by riparian vegetation within the annual floodplains, with stands of valley oak and interior live oak on higher ground. Herbaceous wetland bottoms and upland native grassland communities were common in this vegetation mosaic. The extensive oak forests and riparian/wetland habitats hosted a diverse and abundant wildlife community. Cattle grazing, deforestation of the oak woodlands, and flood protection resulting in expansion of agriculture onto the floodplains in the early to mid-1800's substantially altered both the floodplain and channel vegetation. Agriculture is currently the primary land use in the Central Valley, with the riparian vegetation relegated to narrow strips along portions of the main channel and its tributaries.

Aquatic and Fishery Resources

The fish species assemblages of the Sacramento River include anadromous and resident salmonids and native warm-water river species such as Sacramento sucker and Sacramento pike minnow. The Shasta Lake and Keswick Reservoir fish species include mostly introduced warm-water and cold-water species. The Shasta Lake tributary species include planted and wild trout and several native species. The major non-fish aquatic animal species assemblages of the project area are the benthic macroinvertebrates of Shasta Lake, the Sacramento River and the tributaries to Shasta Lake, and the zooplankton of the reservoirs. **Table 6** gives the common and scientific names of the fish species found in the project area and their likely locations.

TABLE 6
FISH SPECIES KNOWN TO OCCUR IN THE PROJECT AREA

Common Name	Scientific Name	Shasta Lake Tributaries	Shasta Lake / Keswick Reservoir	Sacramento River - Keswick to Red Bluff
Chinook salmon	*Oncorhynchus tshawytscha*			
winter-run				X
spring-run				X
fall-run			X	X
late fall-run				X
Kokanee salmon	*Oncorhynchus nerka*	X	X	
Rainbow trout	*Oncorhynchus mykiss*	X	X	X
Steelhead trout	*Oncorhynchus mykiss*			X
Brown trout	*Salmo trutta*	X	X	
Green sturgeon	*Acipenser medirostris*			X
White sturgeon	*Acipenser transmontanus*	X	X	X
Pacific lamprey	*Lampetra tridentata*			X
Western brook lamprey	*Lampetra richardsoni*			X
Sacramento sucker	*Catostomus occidentalis*	X	X	X
Sacramento pikeminnow	*Ptychocheilus grandis*	X	X	X
Hardhead	*Mylopharodon conocephalus*	X	X	X
Sacramento blackfish	*Orthodon microlepidotus*	X	X	
California roach	*Hesperolecus symmetricus*	X		X
Speckled dace	*Rhinichthys osculus*	X	X	
Golden shiner	*Notemigonus crysoleucas*	X	X	
Carp	*Cyprinus carpio*	X	X	X
Channel catfish	*Ictalurus punctatus*	X	X	X
White catfish	*Ameiurus catus*		X	X
Brown bullhead	*Ameiurus nebulosus*		X	X
Black bullhead	*Ameiurus melas*		X	X
Riffle sculpin	*Cottus gulosus*	X	X	
Prickly sculpin	*Cottus asper*			X
Largemouth bass	*Micropterus salmoides*		X	
Smallmouth bass	*Micropterus dolomieui*	X	X	X
Spotted bass	*Micropterus punctulatus*	X	X	
Black crappie	*Pomoxis nigromaculatus*		X	
White crappie	*Pomoxis annulauris*		X	
Bluegill sunfish	*Lepomis macrochirus*		X	
Green sunfish	*Lepomis cyanellus*	X	X	
Threadfin shad	*Dorosoma petenense*		X	

Water temperature is a very important water quality issue for the Keswick Dam to the RBDD reach of the Sacramento River, primarily because of habitat requirements for salmonids. Four runs of chinook salmon, all of which are listed or are candidates for listing, and Central Valley steelhead trout, which is also listed, spawn and rear in this reach of the river. Maximum survival of incubating salmon and steelhead eggs and yolk-sac larvae occurs at water temperatures between 41 and 56 degrees Fahrenheit, with no survival occurring at 62 degrees Fahrenheit or higher. After hatching, sac fry are completely dependent upon the yoke sac for nourishment and may tolerate water temperatures up to 58 degrees. After juvenile salmon have emerged from the gravel and become independent of the yoke sac, the young salmon are able to tolerate water temperatures up to 67 degrees. Winter-run and spring-run chinook salmon, which lost their historic upper elevation cold-water spawning habitats when Shasta Dam was built, spawn during late spring and summer and, therefore, are particularly vulnerable to water temperature conditions in the river. Winter-run is listed as endangered and spring-run is listed as threatened under the Federal ESA.

For a period after Shasta Dam was constructed, the reservoir was kept relatively full and the cold water released from the hypolimnion (the cold, lower layers of a water body) provided cooler summer temperatures in the downstream reaches. The cold-water releases created suitable conditions for winter-run and spring-run to spawn in the mainstem Sacramento River below Shasta and Keswick Dams. At present, winter-run spawning habitat is almost entirely restricted to the Sacramento River between Keswick Dam and the RBDD and, thus, the survival of winter-run chinook is strongly tied to habitat conditions in this reach. In the 1980s and 1990s, Shasta Lake storage releases were increased to satisfy increasing spring and summer agricultural and urban water demands. The increases depleted the cold-water pool, resulting in warmer water in the river and high moralities of salmon eggs. The NMFS Biological Opinion for winter-run chinook (1993) established water temperature objectives for the river upstream of Jellys Ferry (near RBDD) of 56 degrees Fahrenheit for the period April 15 through September 30, and 60 degrees for October. Recent changes in reservoir operations, including greater carry-over storage, increased imports of cold water from the Trinity River system and, most importantly, the installation of a TCD on Shasta Dam, have substantially improved water temperature conditions in the reach.

Shasta Lake/Tributaries and Keswick Reservoir

The fisheries resources of Shasta Lake are greatly affected by the reservoir's thermal structure. During summer months, the epilmnion (warm surface layer) is 30 feet deep and up to 80 degrees Fahrenheit. Water temperatures above 68 degrees Fahrenheit favor warm-water fishes such as bass and catfish. The deeper water layers, which include the hypoliminion and the metalimnion (transition zone between epilmnion and the hypoliminion) are colder and suitable for cold water species. Shasta Lake is classified as warm monomictic because it has one period of mixing per year.

The warm-water fish habitats of Shasta Lake occupy two ecological zones: the littoral (shoreline/vegetated) and the pelagic (open water) zones. The littoral zone lies along the reservoir shoreline down to the maximum depth of light penetration on the reservoir bottom, and supports populations of spotted bass, smallmouth bass, largemouth bass, black crappie, bluegill, channel catfish and other warm-water species.

The upper, warm surface layer of the pelagic (open water) zone is the principal plankton-producing region of the reservoir. The plankton comprises the base of the food web for most of the reservoir's fish populations. Operation of the Shasta Dam TCD, which helps conserve the reservoir's cold-water pool by accessing warmer water for storage releases in the spring and early summer, may reduce zooplankton biomass, which resides primarily in the reservoir's warmer surface water layer.

The deeper areas of Shasta Lake, hypolimnion and metalimnion, support cold-water species such as rainbow and brown trout and landlocked chinook and kokanee salmon. Native species such as white sturgeon, Sacramento blackfish, hardhead minnow, riffle sculpin, Sacramento sucker and

Sacramento pikeminnow reside in cold water near the reservoir bottom. Trout may congregate near the mouths of the reservoir's tributaries, including the upper Sacramento River, McCloud River, Pit River, and Squaw Creek, when inflow temperatures of these streams are favorable.

The lower reaches of the reservoir's tributaries also provide spawning habitat for reservoir fish populations, particularly trout, and have important resident fisheries of their own. Most of the native species found in the reservoir and listed in the previous paragraph also inhabit the lower reaches of the tributaries. One of the species, the hardhead minnow, is classified as a State of California Species of Special Concern. The McCloud River once supported a population of bull trout, which is currently a State and Federally listed species. A few creeks on the western shore of the reservoir are devoid of biological life because of toxic effluent from local mines.

Sacramento River

The Sacramento River flows for about 59 miles between Keswick Dam and the RBDD. The river in this reach has a stable, largely confined channel with little meander. Riffle habitat with excellent gravel substrates and deep pool habitats are abundant. Immediately below Keswick Dam the river is deeply incised in bedrock with very limited riparian vegetation and no functioning riparian ecosystems. Water temperatures are generally cool even in late summer because of regulated releases from Shasta Lake and Keswick Reservoir. Near Redding, the river comes into the valley and the floodplain broadens. Historically, this area appears to have had wide expanses of riparian forests, but much of the river's riparian zone is currently subject to urban encroachment. This becomes quite extensive in the Anderson/Redding area with homes placed directly within or adjacent to the riparian zone.

The Keswick to Red Bluff reach of the Sacramento River contains a large assemblage of resident and anadromous fish species, including commercially important species and species that are listed as threatened or endangered. The reach produces four separate runs of chinook salmon, which makes it unique among rivers in North America. Despite net losses of gravel since the construction of Shasta Dam, substrates in much of this reach contain gravel needed for spawning by salmonids. This reach provides much of the remaining spawning and rearing habitat of several listed anadromous salmonids. As such, it is one of the most sensitive and important stream reaches in the State.

The salmon that occur in the Sacramento River below Keswick Dam include all four Central Valley runs of chinook salmon: winter-run, spring-run, fall-run and late fall-run. Winter-run chinook is a Federal and State listed endangered species and spring-run chinook is Federally listed as threatened and State listed as endangered. Central Valley fall-run and late fall-run chinook salmon are currently a candidate species for Federal listing. Central Valley steelhead trout, which are Federally listed as threatened also occur in the Sacramento River upstream of Red Bluff and spawn in this reach. Most of these runs historically spawned upstream of the current location of Shasta Dam. With the possible exception of Battle Creek, the Sacramento River and its tributaries above Shasta Dam were the only spawning streams of winter-run chinook salmon. Fortunately, cold water released from Shasta Dam created new spawning habitat in the reach below Keswick Dam. Without these cold-water releases, the winter-run would possibly have been extirpated with the loss of its historic spawning streams. Today, the fall-run, late fall-run and winter-run chinook salmon stocks and the Central Valley steelhead stocks in the Keswick to Red Bluff reach are augmented by production from the Coleman Fish Hatchery on Battle Creek.

In addition to the anadromous salmonids, the Sacramento River contains resident rainbow trout and other native fishes. Resident rainbow trout are particularly abundant in the Keswick to Red Bluff reach. Their abundance has been attributed to stable, cool summer flows resulting from Keswick Dam releases designed to enhance habitat conditions for winter-run salmon. The cool, nutrient-rich flows from the reservoir provide excellent rearing conditions for the trout. Other native species that reside in the Sacramento River upstream of Red Bluff include Sacramento pike minnow, Sacramento sucker and hardhead minnow. White sturgeon and green sturgeon are native anadromous species that have been found at the RBDD. Green sturgeon has been proposed for Federal listing as endangered or threatened.

Vegetation

The Central Valley historically contained an estimated 1,400,000 acres of wetlands. Today, approximately 123,000 acres remain. Riparian and wetland habitats provide food and shelter to aquatic fauna, as well as attenuating high flows. The Sacramento River Valley contains a large diversity of both lowland and upland habitats and species. Along most of the Sacramento River and its tributaries, remnants of riparian communities are all that remain of once productive and extensive riparian areas. However, along the upper reaches of the Sacramento River, a higher percentage of the riparian vegetation is still intact. Vegetation in the river corridor varies from oak/gray pine and chaparral communities with very limited riparian vegetation above Redding to broad riparian ecosystems and agricultural lands from Redding to Red Bluff. Wetlands occupy many areas along Sacramento River waterways, but are not as extensive as wetlands found in the Delta. On the other hand, grasslands and wooded upland communities are more abundant in this region. Agricultural lands also occupy a significant portion of the Sacramento River Basin. Open-water areas occur mainly on the larger waterways, where waterways converge, and in reservoirs.

Shasta Lake and Vicinity

Vegetation in the Sacramento River watershed upstream from Shasta Lake can be separated into seven basic vegetation types: Douglas fir-Mixed Conifer forest, Mixed Conifer, Ponderosa Pine, Canyon Oak Woodland, Black Oak Woodland, Gray Pine Woodland and Chaparral. Elevation ranges for these vegetation types are between 1,065 feet (lake shore) and 5,100 feet (Schell Mountain). This elevation gradient travels through two transition zones: (1) Valley (<1,500 feet) and Lower Montane (Foothill) vegetation types and (2) Lower Montane (1,000 to 3,500 feet) and Montane (>3,000 feet) vegetation types. Plant species diversity is very high.

Lower elevation vegetation consists of a mix of chaparral and hardwoods; mid-elevation slopes are within a transitional zone that contains both the chaparral/hardwood mix and a mixed conifer component; and higher elevation sites are dominated by mixed conifer overstory with brush species in the understory primarily in open areas. An exception to this is in the riparian corridors where conifers can span from lower to upper elevations. Montane riparian is located in narrow belts along many of the tributaries.

Sacramento River

Vegetation in the river corridor varies from oak/gray pine and chaparral communities with very limited riparian vegetation above Redding to broad riparian ecosystems and agricultural lands from Redding to Red Bluff.

Riparian Habitat – Riparian vegetation along the Sacramento River corridor is in the valley foothill riparian association. This habitat has a canopy height of 100 feet with 20 to 80 percent closure. Plant species have specialized adaptations to life in an environment frequently disturbed by flooding and deposition. This vegetative complex provides necessary habitat for many species of native fish and wildlife. Primary native tree species within the riparian forests of the upper Sacramento River include: Fremont cottonwood; White alder; California sycamore; Black walnut; Oregon ash; Red, black and yellow willow; and Valley oak. Numerous native shrubs, vines, grasses and sedges are located within the understory of these trees and, in cases where the tree cover is absent, provide the sole vegetative cover.

Since the river immediately below Keswick is deeply incised in bedrock, there is very limited riparian vegetation and no functioning riparian ecosystems. Near Redding the river comes into the valley and the floodplain broadens and historically had wide expanses of riparian forests. However, the river's riparian zone from Balls Ferry to Keswick is subject to considerable urban encroachment. **Table 7** summarizes existing riparian resources within the 100-year floodplain along the Sacramento River between Keswick Dam and Red Bluff.

TABLE 7
RIPARIAN AND CLOSELY RELATED HABITATS WITHIN THE 100-YEAR FLOODPLAIN ALONG THE SACRAMENTO RIVER BETWEEN KESWICK AND RED BLUFF

Vegetation Type	Acres	Percent of Land Surface Area
Riparian Forests	2,801	15%
Riparian Scrub	1,439	8%
Valley Oak Woodland	315	2%
Marsh	58	<1%
Blackberry Scrub	61	<1%
Total Riparian Vegetation	***4,674***	***26%***

Wetland Habitat – While often combined with riparian ecosystems, wetlands within the project area are defined as shallow to moderately deep open water areas having a vegetative component of emergent and aquatic species (specifically cattails, rushes and sedge). These are normally the result of annual flooding that breaches natural levees along the river, resulting in shallow pools of semi-permanent water. Fairly significant wetland areas exist on tributaries to Shasta Lake and to a limited extent along the Sacramento River downstream to Red Bluff.

Upland Habitat – Upland habitats downstream from Shasta Dam are divided into three categories based on elevation and soil conditions. These include montane hardwood/conifer and blue oak/digger pine (foothill or grey pine) associations from Shasta Dam downstream to Redding, and valley oak woodland adjacent to the river from Redding to Red Bluff. The Montane hardwood/conifer consists of Ponderosa pine, Douglas fir, incense cedar, black oak, Oregon white oak and canyon live oak with relatively little understory. Because of its variety of vegetation and close proximity to other associations, this habitat type provides for a diverse fauna. The Blue oak/foothill pine association is diverse structurally, both horizontally and vertically. The understory shrub layer is sparse and may be limited to annual grassland. The Valley oak woodland association varies from savannah-like to more dense forests with partial canopy-closure. Valley oak woodland is usually associated with conditions where trees can put roots into a permanent water supply, such as along drainages. These woodlands provide abundant food and cover for many species of wildlife.

Wildlife

The composition, abundance, and distribution of wildlife resources in the Sacramento Valley are directly related to available habitat. Overall, fewer wildlife species now inhabit the study area than before agricultural and residential development permanently removed much of the native and natural habitat. Many of the wildlife species are unable to adapt to other habitat types or altered habitat conditions and are, therefore, most susceptible to habitat loss and degradation. Species that were dependent on riparian woodland, oak woodland, marsh, and grassland habitats, have declined accordingly.

Wildlife resources in the primary study area include habitat conditions suitable for over 200 species of birds and 55 species of mammals, reptiles and amphibians. Typical species include owl, raven, gray squirrel, black bear, deer, hummingbird, swallow, elk, ducks, and geese. Lower elevation areas in the McCloud River, Sacramento River, Pit River, and Squaw Creek drainages are also winter ranges for deer. Elk winter range is located in the McCloud River and Pit River peninsulas.

The existing native habitat, especially the riparian corridors along the Sacramento River and associated sloughs and creeks, provide habitat for many native species including blacktail jackrabbit, western gray squirrel, red fox, gray fox, bobcat, raccoon, opossum, mink, longtail weasel, striped skunk, spotted skunk, badger, muskrat, river otter, and beaver. Some amphibians and reptiles found in the study area include the gopher snake, giant garter snake, western fence lizard, common garter snake, and pacific tree frog. Native habitat also provides nesting and feeding habitat for resident birds.

Riparian habitat provide shade, cover, and food supply to the immediate shoreline environment of large rivers, benefiting fish and wildlife species such as salmonids, native fishes, river otter, beaver, herons, egrets, and kingfisher.

Special-Status Species

Sacramento River Basin is home to 65 special-status plant species, nine special-status fish species, and 39 special-status wildlife species. Most of the plant species live in grasslands, including vernal pools. The next-greatest number of special-status species inhabits chaparral and montane hardwood areas. Most of the special-status fish and wildlife species inhabit grasslands, freshwater emergent wetlands, lakes, and rivers on the valley floor. Federal and State wildlife agencies have listed many species.

Plants

Plants considered by the State and/or the FS to require special attention are designated as "sensitive." Plants potentially within the project area under this designation are shown in **Table 8**. There are no known populations of listed plants in the project area.

TABLE 8
POTENTIAL HABITAT FOR SPECIAL STATUS PLANTS IN THE SHASTA LAKE WATERSHED

Species	Status	Habitat	Nearest population to watershed
Arnica venosa Veiny arnica	Endemic	Hot dry slopes under pine, black oak and Doug fir. Usually on north-facing aspects or ridgetops. Elevation: 1,500-5,000 feet.	There are two populations in the primary study area.
Cypripedium faciculatum Clustered lady's slipper	Sensitive	Mixed conifer or oak forests on a variety of soil types, often but not always associated with streams; 1,300-6,000 feet elev. Widespread but sporadic.	No known populations on the Shasta side of the forest. There are several populations on the Trinity side of the forest.
Cypripedium montanum Mountain lady's slipper	Sensitive	Mixed conifer or oak forests on a variety of soil types, often but not always associated with streams; 1,300-6,000 feet elev. Widespread but sporadic.	There is one known population along the Soda Creek Rd., approx. 18 miles northeast of the watershed.
Lewisia cantelovii Cantelow's lewisia	Sensitive	Moist rock outcrops in broad-leaf and conifer forests; elev. 500 to 3,000 feet.	There are two populations near Lamoine, approx. 2 miles north of the watershed.
Neviusia cliftonii Shasta snow-wreath	Sensitive	North-facing slopes on limestone-derived soils, within riparian zones; Elev. 2,400 to 3,000 feet.	3 miles east in Waters Gulch. There is a small amount of limestone outcrop in Big Backbone Creek and Little Backbone Creek.
Source: Shasta Lake West Watershed Analysis, U.S. Forest Service, 2001.			

Fish and Wildlife

Within the primary study area there is the potential for occupancy by twelve species listed as threatened or endangered under the ESA and/or the California Endangered Species Act (CESA). These species (see **Table 9**) are provided protection by one or both of these acts and any actions resulting in take must be permitted by the FWS and the DFG. In addition, the project area has the potential to host species of special concern, also shown in **Table 9**. Species of special concern, while not offered protection under the endangered species acts, require analysis and mitigation under California Environmental Quality Act (CEQA).

TABLE 9
ENDANGERED, THREATENED, AND SPECIAL STATUS FISH AND WILDLIFE SPECIES

Species	Status	Habitat Specifics
Federal and State Threatened and Endangered Species		
Valley elderberry longhorn beetle	FE	Riparian; requires mature elderberry bushes
Chinook salmon (winter-run)	FE, SE	Sacramento River and tributaries
Chinook salmon (spring-run)	FT, ST	Sacramento River and tributaries
Bald eagle	FT,SE	Riparian zones along larger rivers and open water areas w/large trees for nesting and roosting
California red-legged frog	FT	Still or slow-moving water w/shrubby riparian vegetation. Extinct in project area.
Steelhead	FT	Sacramento River and tributaries
Peregrine falcon	SE	Riparian zones for wintering habitat
Yellow-billed cuckoo	SE	Riparian forests greater than 50 acres
Shasta salamander	ST	McCloud River, Pit River, and Squaw Creek in moist limestone fissures and caves
Swainson's hawk	ST	Riparian areas w/ large trees for nesting; adjacent open lands for foraging
Bull trout	SE, FT	McCloud River
Bank swallow	ST	Steep river banks and bank near water sources
Species of Special Concern		
California tiger salamander	SC	Wetland and vernal pools and adjacent uplands
Foothill yellow-legged frog	SC	Shallow river and streams with gravel bottoms
Western spadefoot toad	SC	Vernal pools and ponds
Western pond turtle	SC	Moderate to deep slow-moving rivers, ponds and streams having deep pools.
Hardhead Minnow	SC	Shasta Reservoir and tributaries
Chinook Salmon (fall/late-fall-run)	SC	Sacramento River and tributaries
Ferruginous hawk	SC	Wintering populations only; grasslands.
Cooper's hawk	SC	Riparian zones
Sharp-shinned hawk	SC	Riparian zones
Merlin	SC	Riparian zones for wintering habitat
Osprey	SC	Riparian zones along larger rivers and open water areas w/large trees for nesting and roosting
Western least bittern	SC	Marshy areas with emergent vegetative cover
White-faced ibis	SC	Irrigated pastures, shallow marsh
Black tern	SC	Marsh lands w/permanent open water
California gull	SC	Wintering populations only; riverine and wetlands
Long-billed curlew	SC	Grasslands and irrigated pastures
Burrowing owl	SC	Grasslands
Long-eared owl	SC	Riparian habitat w/dense canopies
Short-eared owl	SC	Open areas with few trees; grasslands, irrigated pastures.
Vaux's swift	SC	Coniferous (Douglas fir) habitats; snags
California horned lark	SC	Grasslands
Loggerhead shrike	SC	Oak woodland
Purple marten	SC	Riparian forests
Tri-colored blackbird	SC	Marsh
Yellow-breasted chat	SC	Riparian scrub
Yellow warbler	SC	Riparian scrub/forests

Key:
FE=Federally endangered, SE=State endangered, FT=Federally threatened, ST=State threatened, SC=Regarded by the FWS and/or CDFG as a species of special concern.

Wild and Scenic

In the Shasta Dam area, the free-flowing stretches of the McCloud River are protected under the California Wild and Scenic River Act of 2002 (Public Resources Code Section 5093.50). Under the act, the State legislature made the finding that "maintaining the McCloud River in its free-flowing condition to protect its fishery is the highest and most beneficial use of water". The act restricts the construction of dams, reservoirs, diversions, or other water impoundment facilities on the McCloud River from the location of the present confluence of the McCloud River with Shasta Reservoir (McCloud Bridge). With the exception of participation by the DWR in studies involving the feasibility of enlarging Shasta Dam, the act prohibits any State department or agency from assisting or cooperating with any agency of the Federal, State, or local government in planning or constructing any facility that could have an adverse effect on the free-flowing condition of the McCloud River or on its wild trout fishery.

Social and Economic Resources

Population

It is estimated that the number of persons living in California as of April 1, 2000 totaled almost 34 million. The 2000 census counted 2.4 million persons residing within Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yuba, Yolo, Sacramento, and Solano counties. About three-fourths of the population reside in and near the City of Sacramento. Shasta County (the Redding Metropolitan Area) had about 163,300 residents. Population growth during the 1990-2000 decade totaled approximately 4.1 million persons for the State, 328,300 for the greater Sacramento River Valley area, and 16,200 for Shasta County.

Population growth in California has created demands for land and water resources for residential, commercial, and infrastructure uses. As population has increased, urbanization has converted substantial amounts of land from agriculture, wetland, open space, and other land use categories to roads, parks, housing, retail stores, office space, and other urban uses. This has also included increased demand for a more dependable water supply.

Land Use

Land uses in the Sacramento River Valley are principally agricultural and open space, with urban development focused in the Sacramento metropolitan area. Urban development has occurred along major highway corridors, primarily in Sacramento, Placer, El Dorado, Yolo, Solano, and Sutter counties, and has taken some agricultural land out of production. Soil conditions in the basin allow a wide variation in crop mix.

The primary private land use in the region is agriculture. As of 1997, California's 74,126 farms included a total of 27.7 million acres. Of that, the Sacramento River Valley area had over 11,000 farms with about 4.3 million acres. Shasta County's 850 farms encompassed a total of almost 317,000 acres. The region has extensive tracts of Federal and State land, including portions of the Shasta-Trinity, Lassen, Plumas, and Mendocino National Forests plus several Federally- or State-owned wildlife management areas.

Employment and Business/Industrial Activities

It is estimated that in August 2002, California's civilian labor force totaled 17.5 million. During 2001, approximately 1.2 million persons, or half of the persons in the Sacramento River Valley area, were in the civilian labor force. The area's rate of unemployment ranged from 4.1 percent in Solano County to 17.6 percent in Colusa County. For the year 2001, Shasta County had a labor force that averaged 76,487 of whom 71,332 were employed and 5,155 unemployed. This represents an unemployment rate of 6.7 percent.

The State's economy is based on the manufacture of computers and electronic products, transportation equipment (particularly aerospace products), fabricated metal products, machinery, and food processing; business services; and farming. The economy of the central and northern counties in the Central Valley is based on lumbering and the manufacture of wood products, and farming and food processing. In the year 2000, manufacturing establishments employed 74,046 workers in the Central Valley. Shasta County manufacturers accounted for 5,039 of these jobs or 6.8 percent for the area. The manufacturing sector in the Central Valley had sales totaling almost $17.0 billion; and Shasta County's manufacturing establishments earned $635 million.

Shasta County's economy has expanded as the result of the provision of new health service facilities, shopping centers, and recreational services for non-residents of that county. Tourism, recreation, and related hospitality industries are a major source of economic development in the primary study area. In 1998, travel-related spending alone exceeded $360 million in Shasta County, generating over 4,600 jobs. Shasta Lake and the Sacramento River play a central role in the tourism industry and the appeal of the region to prospective businesses and investors.

Local Government and Finance

Local government services in California are provided by counties, school districts, fire districts, water districts, and other special districts. Based on 1997 census data, it is estimated that all local governmental units operating within the 10-county Sacramento River Valley area had revenues totaling almost $8.8 billion or about $3,950 per regional resident. Shasta County's governmental units had combined revenue of about $644 million or $3,983 per resident. Forty-one percent of the combined revenue of all the local governmental units operating within the Sacramento River Valley area was derived from the transfer of State governmental revenue and about 19 percent from local taxes.

Public Health and Safety

Data from the 1997 census indicate that local governmental units operating within the region employed about 4,200 full-time workers and spent about $310 million or $139 per regional resident to provide health and hospital services. Local Governmental units in Shasta County spent about $36 million or $223 per county resident on the provision of public health services. Shasta and Tehama counties are the only jurisdictions in the Sacramento River Valley area in which hospital care is provided by local government.

State Police, County Sheriffs, fire districts, and county-run detention facilities provide public safety in California's rural areas and smaller incorporated places. Larger cities in the State almost always provide police and fire services within their jurisdictions. In 1997, local governments within the Sacramento Valley employed about 7,500 workers to provide police and fire protection. This number included about 5,000 workers for police protection and about 2,400 for fire protection. Shasta County's local governments employed a total of 467 workers to provide public safety, including 364 for police protection and 103 for fire protection. Annual expenditures for public safety in the Sacramento River Valley area totaled $732 million or $329 per regional resident. The provision of public safety in Shasta County cost $48 million or $297 per county resident.

Traffic and Transportation

The major transportation routes in the study area include: Interstate 5, which traverses the valley from north to south; State Route 299, an east-west route, traverses Trinity, Shasta, Lassen, and Modoc counties in the northern watershed areas; and State Route 99 and State Route 70, portions of which are expressway, also run north-south from Sacramento northward toward Chico. The upper watershed areas west and east of the Sacramento Valley contain a network of State highways. Major routes on the west side of the valley include State Route 29, which runs north-south through Napa and Lake counties and several east-west freeways including State Route 20 in Lake County, State Route 162 in Glenn County, and State Route 36 in Tehama and Trinity counties. Excluding Chico, traffic within the central and northern portions of the Central Valley usually is moderate to light. During weekends and holidays from May 1 through Labor Day, however, heavy traffic in the Redding-Shasta Lake area is not unusual.

Recreation and Public Access

Major recreation areas in the Sacramento River Basin include lakes and reservoirs, rivers and streams, Federal wildlife refuges, and State wildlife management areas. Private lands also support considerable waterfowl hunting activity in the region. Shasta Lake, Whiskeytown Lake, Lake Oroville, Folsom Lake, New Bullards Bar Reservoir, and Englebright Lake provide extensive reservoir recreation opportunities, including flat-water recreation.

Information from the 1997 census indicates the importance of outdoor recreation in Shasta County. The county's accommodation and food services establishments had sales totaling $162 million or almost $1,000 per county resident. This per capita amount is the highest of all the counties in the Sacramento River Basin. Outdoor recreation and tourism in Shasta County is the result of Shasta Lake. FS personnel in Redding report that the lake has attracted the development of: 11 marinas with 1,075 houseboats, including 625 that are privately owned and 450 that are owned by a marina and rented on a weekly or weekend basis, and 18 developed public campgrounds with a total of 246 sites. In addition, several of the lake's marinas have developed rental campsites and numerous cabins on land leased from the FS. Access to most of the campgrounds, day-use areas, and marina/resorts around Lake Shasta is provided by Interstate 5 and secondary roads maintained by the FS or Shasta County.

Utilities and Public Services

Various departments within the cities and counties of the Sacramento River Valley provide highly efficient fire protection, police protection, and emergency services to members of their respective communities. There is a vast network of utility generation/transmission systems and service providers cross all regions of the study area, supplying urban and rural areas with power, water, and emergency services. Other significant infrastructure consists primarily of hydroelectric and natural gas-fired generating facilities, transmission lines, substations, distribution lines, fiber optic and cable lines, and communication towers. Pipelines, storage areas, and compressor stations are located in the Sacramento Valley.

Water Supply

On the basis of information contained in the 1998 DWR California Water Plan (Bulletin 160-98), water demands (applied water) in the State in 1995 for urban, agricultural, and environmental purposes under average and drought year conditions amounted to about 79.5 and 65 MAF, respectively. To address this demand, available state-wide supplies from surface water, groundwater, and recycled and desalted sources also under average and drought year conditions amounted to about 78 and 60 MAF, respectively. During average years about 84 percent of the available supplies come from surface water sources and 16 percent from groundwater. In dry years the water from surface water sources decline to about 73 percent of the available supplies and nearly all of the remainder (about 27 percent) comes from groundwater.

Similar conditions existed in the Central Valley. As can be seen in **Table 10**, the estimated 1995 water demands during average and drought years in the Sacramento River, San Joaquin River, and Tulare Lake Basins were about 38.8 and 35.4 MAF, respectively. The total estimated water supply for both average and drought year conditions were about 37.5 and 31.8 MAF, respectively. Total net water demands (or shortages) ranged from about 1.2 to 3.5 MAF for average and drought year conditions, respectively.

As mentioned, the largest water supply provider in the Central Valley is the CVP. The total annual contract water amount in the CVP is about 8.3 MAF. However, the project can only deliver portions of this amount depending on various conditions. As presented in Bulletin 160-98, the CVP has a 7 MAF delivery capability under average year conditions. Of this 7 MAF, 3 MAF is in the Northern (Sacramento) CVP System, 2.7 MAF in the Southern (San Joaquin) CVP System, and 1.3 MAF in the Eastside and Friant Divisions. On the basis of more recent system modeling runs, however, it is estimated that the system delivery capability under average year conditions and year 2000 demands is about 10 percent less, at an estimated 6.3 MAF. If this is true, then the potential shortages in **Table 10** are significantly larger than previously estimated.

Figure 4 shows the expected frequency that the Northern and Southern CVP Systems can meet estimated annual deliveries under current (2000) conditions. As can be seen, under year 2000 demand conditions in 80 percent of the years it is estimated that the system can deliver at least 4.5 MAF and in 20 percent of the years at least 5.8 MAF. The median annual delivery (50 percent exceedence) is about 5.5 MAF.

TABLE 10
YEAR 1995 - ESTIMATED WATER DEMANDS, SUPPLIES, AND SHORTAGES
(1,000 ACRE-FEET)

Water Condition	Hydrologic Basin						Three Basin Total	
	Sacramento River		San Joaquin River		Tulare Lake			
	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year
Applied Water								
Urban	766	830	574	583	690	690	2,030	2,103
Agricultural	8,065	9,054	7,027	7,244	10,736	10,026	25,828	26,324
Environmental	5,833	4,223	3,396	1,904	1,672	809	10,901	6,936
Total	14,664	14,107	10,997	9,731	13,098	11,525	38,759	35,363
Water Supply								
Surface Water	11,881	10,022	8,562	6,043	7,888	3,693	28,331	19,758
Groundwater	2,672	3,218	2,195	2,900	4,340	5,970	9,207	12,088
Recycled/Desalted	0	0	0	0	0	0	0	0
Total	14,553	13,240	10,757	8,943	12,228	9,663	37,538	31,846
Shortage	***111***	***867***	***240***	***788***	***870***	***1,862***	***1,221***	***3,517***

Source: The California Water Plan, Bulletin 160-98, Appendix 6A, Regional Water Budgets with Existing Facilities and Programs, November 1998.

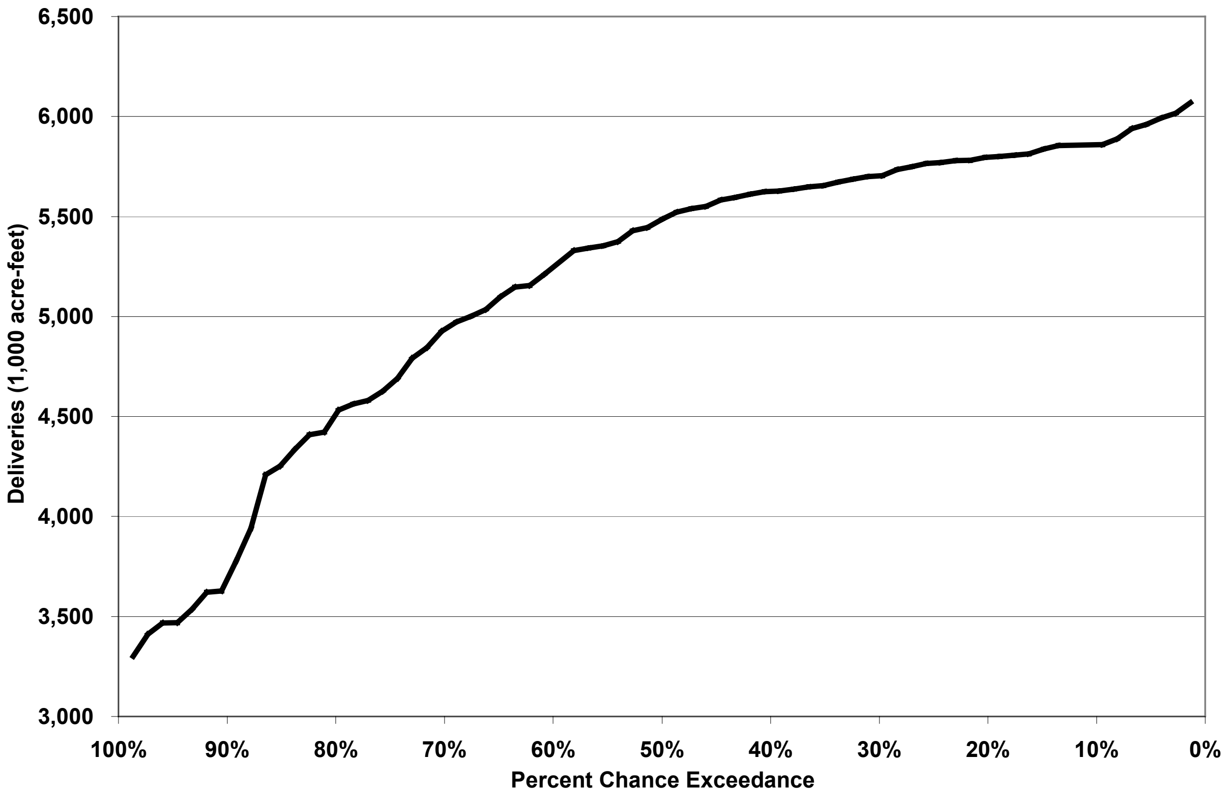


Figure 4 – Estimated Frequency (Percent Exceedance) of Total CVP Deliveries in the Northern and Southern CVP Systems (Excluding Madera and Friant-Kern Systems) with Year 2000 Level Demands and D-1485 Requirements

When deficiencies in the ability of the system to deliver full entitlements occur as indicated in **Table 10** and **Figure 4**, deliveries are reduced by varying percentages based on demand type (i.e., refuges, settlement contracts, and CVP contracts). The priority deliveries include wildlife refuges north and south of the Delta and water required by the CVP Exchange and Settlement Contractors. The discretionary deliveries, which can be significantly shorted depending on the type of water year, include agricultural and M&I CVP contractors both north and south of the Delta.

Power/Energy

Major energy generators in the study area include the SWP, CVP, and private suppliers. The primary purpose of the SWP power generation facilities is to meet energy requirements for the SWP pumping plants. To the extent possible, SWP pumping is scheduled during off-peak periods, and energy generation is scheduled during on-peak periods. Although the SWP uses more energy than it generates from its hydroelectric facilities, DWR has exchange agreements with other utility companies and has developed other power resources. When available, surplus power is sold by DWR to minimize the net cost of pumping energy.

CVP power generation facilities initially were also developed based on the premise that power could be generated to meet project use loads. The Reclamation Act of 1939 provided for surplus power to be sold first to preference customers, including irrigation and reclamation districts, cooperatives, public utility districts, municipalities, and large educational or government facilities. Surplus commercial power may be sold to non-preference utility companies.

The California Independent Systems Operator (ISO) synchronizes all major electrical loads and generators within the State boundaries to operate as a single cohesive system. In addition to the California ISO, there is a much broader system of electric generation and transmission with which the CVP and SWP interact called the Western Systems Coordinating Council (WSCC). These interactions with the WSCC could extend over the entire West Coast and inland to the desert regions of the Southwest.

Other major hydroelectric facilities present in the study area are investor-owned utility companies, such as PG&E and Southern California Edison (SCE); by municipal agencies, such as the Sacramento Municipal Utility District (SMUD); and by several water and irrigation districts. Some of the larger facilities outside the CVP and SWP systems in the Sacramento Valley area include PG&E's Pit System (317 MW) and McCloud-Pit System (340 MW) in Shasta County, PG&E's Upper North Fork Feather River System (340 MW) in Plumas County, SMUD's Upper American River Project System (640 MW) in El Dorado County, and Yuba County Water Agency's Yuba River Project (300 MW) in Yuba County.

Hazardous Materials and Waste

Types of hazardous waste sites in the Sacramento River Basin include contaminated agricultural ponds; hazardous materials spills; and leaking tanks or pipelines from industrial sites, railroad operations, commercial sites, and mining. Metals such as cadmium, copper, mercury, and zinc, are present in inactive and abandoned mines in the Sacramento River drainage. Inactive underground mines and surface waste piles at Iron Mountain, California, in the Clear Creek watershed, have extremely acidic drainage with high concentrations of toxic discharges and metals.

Fire Hazard

Fire suppression policies and large-scale grazing have caused the rate of material decomposition to decline dramatically, and have led to fuel accumulation throughout most of the wild lands of the Sacramento River Basin. Fire suppression efforts also have reduced the frequency of wildfires and greatly reduced the land areas impacted by the fires.

Natural Resources

The State's scenic beaches and mountains, mild climate, extensive rivers with cold-water fisheries, fertile soil, and forested areas have been a major factor behind the in-migration of persons from other areas. The soil and climate of the Central Valley have brought about its development as a major agricultural area specializing in fruits, vegetables, rice, and other farm products. Farm production, in turn, has stimulated the development of food processing establishments as well as businesses that provide services for the area's farms. Similarly, extensive timber resources have been the catalyst behind the growth of its lumber and wood products manufacturing. The development of Shasta Lake has resulted in Shasta County becoming a major outdoor recreational area, which attracts significant numbers of recreationalists who reside outside of Shasta County.

Aesthetics

Visual resources in the Sacramento River Valley are characterized by agricultural uses in the Sacramento Valley, grasslands and woodlands in the foothills, and forests in the upper watersheds. The Sacramento Valley's upper watershed retained its predominantly oak woodland, grasslands, forests, and small rural communities despite substantial development along Federal and State highways in the foothills and mountain areas. These areas are framed by the forested ridgelines of the Sierra Nevada to the east, the Cascade Range to the north, and the Coast Ranges to the west. Little urbanization in these areas has preserved pristine wildernesses, mountains, and other dramatic landscapes.

Shasta Lake added visual variety to this region. Viewer sensitivity is high in this area because of high recreation use and easy public access. A scenic highway is a road designated by the State or local agencies as having exceptional scenic qualities or affording panoramic vistas. Highway 151 (from Shasta Dam to near Summit City) is officially designated a State scenic highway.

Cultural Environment

Paleontology

California is geologically diverse, with metamorphic and both intrusive and extrusive igneous rock formations as well as a wide range of fossil-bearing sedimentary rock formations. Within the Shasta Lake area, there are both metasedimentary and metavolcanic formations, and more recent volcanic deposits as well. Sedimentary deposits are prominent in the area. The Triassic Hoselkus Limestone contains both marine invertebrates such as ammonites, and marine vertebrate remains including icthyosaurs and thallatosaurs. Solution caves in the Permian McCloud Limestone contain a significant Pleistocene fauna, including remains of horses, bison, giant bears, dire wolves, ground sloths, and mammoths.

Archaeology

California is rich in both prehistoric and historic archaeological remains. The Central Valley has been an especially productive region, with many deeply stratified sites that have produced information of crucial importance in understanding the prehistory of the state. The Shasta Lake area was little known until quite recently; on into the 1950s it was believed that the area was unoccupied prior to AD 900, after which the Shasta area was occupied primarily by ancestors of the Wintu people. Subsequent investigations revealed repeated occupation of the area as early as 8,000 years ago. Archaeological remains also represent ancestors of the Yana people. Historic archaeological sites represent remains from various historic era activities in the Shasta Lake region, especially relating to fur trapping, mining, early settlement and agriculture (farming and ranching).

The Shasta Reservoir area has been surveyed for archaeological remains on numerous occasions. Thirty-seven sites were recorded in the 1940s prior to construction of Shasta Dam, but it is doubtful that this constituted an intensive survey by contemporary standards. During a drought in 1976-1977, the FS revisited previously recorded sites, and surveyed areas usually inundated, but again it is unclear whether this was a complete survey. Areas above gross pool apparently have been surveyed haphazardly and are highly incomplete.

From available information, it is estimated that there are at least 118 archeological sites believed to be inundated by Shasta Reservoir at gross pool elevation (1,076 feet). Of these, an estimated 76 sites are below gross pool but above the minimum pool elevation (840 feet). Of the 118 sites, the great majority (101) are prehistoric sites. There are also 7 historic sites and 10 multi-component (prehistoric/historic) sites. Around the reservoir to elevation 1,276 feet, there is estimated to be another 55 archeological sites. Of these, 50 are prehistoric sites, 4 historic sites, and 1 multi-component site.

History

Northern portions of the Central Valley are largely unmentioned in records of the Spanish and Mexican-era activities which occurred in the more southerly coastal portions of the state. The earliest historic records pertaining to the Shasta Lake area are from Hudson's Bay Company fur trappers. Malaria, introduced by fur trappers in the area, had devastating effects on aboriginal populations. Gold, copper and iron mining were important activities in the Shasta Lake area during the latter half of the nineteenth century, and later activities included settlement by farmers and ranchers. Most known historic archaeological sites are related to mining, transportation, commerce and recreation.

Historic sites include historic buildings and lodges and historic hiking and fishing trails. On the McCloud River, a private fly-fishing club has been in operation since 1904. Its lodges date from the 1860s. Some lodges are likely eligible for inclusion in the registers of national and State historic structures.

Ethnography

California is home to many linguistically and culturally diverse Native American groups. Within the Shasta Lake area, archeological and ethnographic sites include Indian villages, locations where ceremonies were held, burial grounds, and a number of other types of sites. Large portions of the Sacramento River, McCloud River, and Squaw Creek watersheds were known to have populations of the Wintu Tribe. Sites are known to occur on lands adjacent to Shasta Lake. The Wintu is a group whose language belongs to the Penutian family. These people are believed to have arrived in California around 1,000 BC. The Wintu lived primarily in large villages along the rivers in their territory; they fished for Chinook salmon in the McCloud and Sacramento rivers, and hunted deer and other animals. They also ate large quantities of acorns and other vegetable foods. Several local groups lived within the Shasta Lake area, including the *Nomtipom*, the *Winnemem*, and the *Waimuk*.

The Okwanuchu were another group, related to the Hokan-speaking Shasta people of southern Oregon, who lived in the McCloud River drainage. Another distinct group was the *Madesi* band of Achumawi, farther east along the Pit River. In addition, the Central Yana people held territory in the Cow Creek drainage.

Numerous sacred sites are located immediately above the existing gross pool of Shasta Reservoir. These include burials and cemeteries, places of spiritual power, named villages, and other sites of special concern. The California Native American Heritage Commission identified a number of locations of particular concern.

FUTURE WITHOUT-PROJECT BASELINES

Identification of the magnitude of potential water resources and related problems and needs in the study area is not only based on the existing conditions above, but also on an estimate of how these conditions may change in the future. Two baseline were identified to help define the extent of potential resources problems/needs and for use in identifying the relative effectiveness of alternative plans to be formulated to address these problems/needs. They include:

- **CEQA Baseline –** This baseline is important for developing the Environmental Impact Report (EIR) to meet requirements of CEQA. Under this baseline, future conditions are assumed to be equal to existing conditions.

- **National Environmental Policy Act (NEPA) Baseline –** Under this without-project future condition, only actions reasonably expected to occur in the future would be included. This would include projects and actions that are currently authorized, funded, permitted, and/or highly likely to be implemented. The NEPA Baseline is important for developing the Environmental Impact Statement (EIS) to meet the requirements of NEPA. The NEPA Baseline includes the CEQA Baseline for existing conditions.

Projecting what may happen in the future, without a potential action to resolve the problems/needs identified in the study, is complicated by ongoing programs and projects primarily related to CALFED and the CVPIA. Accordingly, although not authorized or under construction, ongoing ecosystem restoration efforts are likely to be implemented through various small projects. Collectively these efforts would improve the quantity and value of freshwater emergent marsh, scrub-shrub, riparian, oak woodland, annual grasslands, agricultural habitat, wildlife, fishery and aquatic resources, and special–status species. Much of this improvement would be based on separate opportunities that are not integrated in a single plan.

Several significant projects that are expected to be implemented in the future in and near the primary study area and to be included in the NEPA Baseline (for consideration in both conditions with or without a modification of Shasta Lake) include:

- **Sacramento River National Wildlife Refuge –** Land acquisition and habitat restoration program along the Sacramento River between Colusa and Ord Bend.

- **Folsom Modifications –** Enlarging the existing outlets and constructing new low level outlets to increase the releases during lower pool stages, and revising the surcharge storage space in the reservoir.

- **Environmental Water Account (EWA) –** As mentioned, the EWA is a cooperative short-term management program to provide protection to fish of the Bay-Delta estuary through changes in SWP/CVP operations at no uncompensated water costs to the projects' water users. The program appears to be very successful and it is believed that some form of it will continue into the long-term future.

- **Water Use Efficiency –** CALFED seeks to accelerate the implementation of cost-effective actions of their water use efficiency program to conserve and recycle water throughout the State. As with the EWA, it is believed that some form of this program will develop and continue into the long-term future.

- **South Delta Improvements –** One of the potential South Delta Improvement projects included in the CALFED Conveyance program is increasing the SWP pumping criteria to 8,500 cfs during certain periods. Although the potential project is still in the planning phase and not yet approved, it will be included as a without-project condition in future studies. This is primarily because it is an essential element of the ROD, has significant funding allocated under California Proposition 13, and broad state and Federal agency support.

- **Trinity River Restoration Plan** – It is expected that over time, the elements of the December 2000 ROD for the Trinity River Restoration Plan will be implemented. This includes reducing annual exports of the Trinity River water to the Sacramento River from 74 percent of the Trinity River flow to 52 percent.

- **Phase 8 Short-Term Agreement** – It is highly likely that some of the 45 projects identified in the Phase 8 Short-Term Settlement Agreement will be implemented. This includes a portion of the 185,000 acre-feet of water for environmental needs. It is likely that the portion of this water not requiring construction of new infrastructure will be made available.

- **Other Projects** – There are various other projects and programs that are expected to be implemented in the future. Several include the Battle Creek Restoration Project, CVP Contract Renewals, and further implementation of the CVPIA (b)(2) water accounting.

FUTURE WITHOUT-PROJECT CONDITIONS

Summarized below are some of the expected physical, environmental, and socio-economic conditions generally expected to occur in the future.

Physical Environment

Basic physical conditions in the study area are expected to remain relatively unchanged in the future. No changes to area topography, geology, soils, and seismicity are foreseen. From a geomorphic perspective, on-going restoration efforts along the rivers are expected to marginally improve natural riverine processes. Without major physical changes to the river systems, which is unlikely, hydrologic conditions will likely remain unchanged. There is some speculation that the region's hydrology could be altered should there be significant changes in global climatic conditions. Scientific work in this field of study is continuing.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Further, efforts are underway to better manage the quality of runoff from urban environments to the major stream systems. However, water quality conditions are expected to generally remain unchanged and similar to existing conditions. Most of the air pollutants in the study area will continue to be influenced by both urban and agricultural land uses. As the population continues to grow, with about 4 million additional people expected in the Central Valley by the year 2020, and agricultural lands are converted to urban centers, a general degradation of air quality conditions could occur.

Biological Environment

Significant efforts are underway by numerous agencies and groups to restore various biological conditions throughout the study area. This includes elements of the CALFED programs, Upper Sacramento River Conservation Area program, efforts by The Nature Conservancy and other private conservation groups, and numerous other programs and projects. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored. However, as population and urban growth continues and land uses are converted to urban centers, many of the wildlife species especially dependent on woodland, oak woodland, and grassland habitats may be impacted.

Efforts are also underway to implement programs and projects to help restore fisheries resources. Although significant increases in anadromous and resident fish populations in the Sacramento River are likely to continue through implementation of projects such as the Battle Creek Restoration Project, some degradation will likely occur through actions such as reduction in Sacramento River flows and resulting elevated water temperatures due to reduced diversions of cooler water from the Trinity River. Accordingly, populations of anadromous fish are expected to remain generally similar to existing conditions.

Through the significant efforts of Federal and State wildlife agencies, populations of Special-Status Species in the riverine and nearby areas will generally remain as under existing conditions.

Social and Economic Environment

The population of the State is estimated to increase from 37 million in 2000 to about 49 million by 2020. The population of the Central Valley is expected to increase from approximately 7 million people in 2000 to about 11 million people by 2020. In the Sacramento River region, the population is expected to increase from about 3 million to about 4.1 million by 2020. To support the expected increase in population, some conversion of agricultural and other rural land to urban uses is anticipated. To accommodate the increasing population, modification of existing major traffic corridors is also anticipated. Increased transportation routes are likely to be constructed to connect the anticipated population increase in the Central Valley to existing transportation infrastructure.

The anticipated increases in population growth in the Central Valley will result in increased demands on water resources systems for additional and reliable water supplies, energy supplies, water-oriented facilities, recreational facilities, and flood damage reduction facilities.

Table 11 summarizes Bulletin 160-98 estimated water demands (applied water), supplies, and potential shortages for year 2020 levels of demand in the Sacramento, San Joaquin, and Tulare hydrologic basins of the Central Valley. As shown in the table, estimated future shortages of water supplies are expected to be nearly 0.9 MAF in average years and 3.6 MAF in drought years. It is believed, however, based on updated system modeling that the CVP system may only be capable of delivering about 90 percent of that projected in Bulletin 160-98. Accordingly, it is believed that the potential water shortages under year 2020 demands and average and drought year conditions would likely be significantly greater than shown in **Table 11**.

TABLE 11
YEAR 2020 - ESTIMATED WATER DEMANDS, SUPPLIES, AND SHORTAGES
(1,000 ACRE-FEET)

Water Condition	Hydrologic Basin						Three Basin Total	
	Sacramento River		San Joaquin River		Tulare Lake			
	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year
Applied Water								
Urban	1,139	1,236	954	970	1,099	1,099	3,192	3,305
Agricultural	7,939	8,822	6,450	6,719	10,123	9,532	24,512	25,073
Environmental	5,839	4,225	3,411	1,919	1,676	813	10,926	6,957
Total	14,917	14,283	10,815	9,608	12,898	11,444	38,630	35,335
Water Supply								
Surface Water	12,196	10,012	8,458	5,986	7,791	3,593	28,445	19,591
Groundwater	2,636	3,281	2,295	2,912	4,386	5,999	9,317	12,192
Recycled/Desalted	0	0	0	0	0	0	0	0
Total	14,832	13,293	10,753	8,898	12,177	9,592	37,762	31,783
Shortage	***85***	***990***	***62***	***710***	***721***	***1,852***	***868***	***3,552***

Source: The California Water Plan, Bulletin 160-98, Appendix 6A, Regional Water Budgets with Existing Facilities and Programs, November 1998.

The anticipated increases in population growth will also have impacts on visual resources within the Central Valley, as areas of open space on the valley floor are converted to urban uses. These increases will also result in increased demands for electric, natural gas, water, and wastewater utilities; public services such as fire, police protection, and emergency services; water-related infrastructure; and communication infrastructure. Further, the increasing population will increase the potential for hazardous toxic radiologic waste issues in the future. It will also place pressures on preservation of existing historical and pre-historical cultural sites within the study area.

The increase in population and aging 'baby boomer' generation will increase the need for health services. During the 2000-2010 decade, many workers will reach 60 years and older. The general migration of retirees and older Americans from colder northeastern regions to warmer southern regions is expected to continue. While many of the region's high school graduates will leave the area for colleges and jobs located in San Francisco and southern California, the region's superior outdoor recreational opportunities and moderate housing costs are expected to attract increasing numbers of retirees from outside the region. Increasing numbers of residents, in turn, will produce increased employment gains, particularly in the retail sales, personal services, finance, insurance, and real estate sectors.

Cultural Environment

Any paleontological, historic, or ethnographic resources currently being affected by erosion due to reservoir fluctuations would continue to be impacted. Fossils and artifacts located around the perimeter of the existing reservoir will continue to be subject to collection by recreationalists. Resources located within the potential inundation zone of an enlarged Shasta Lake will likely be unaffected.

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CHAPTER IV
WATER AND RELATED RESOURCES PROBLEMS AND NEEDS

ANADROMOUS FISH SURVIVAL

The population of Chinook salmon has significantly declined over the past 30 years. There are numerous factors contributing to the decline including: water diversions from the Sacramento River; drought conditions; reduction in suitable spawning gravels; fluctuations in river flows; toxic acid mine drainage; unnatural rates of predation; and fish harvests. However, one of the most significant environmental factor is unstable water temperatures.

Water temperatures that are too high or in some cases too low can be detrimental to salmon. Elevated water temperatures can negatively impact spawning adults, egg maturation and viability, and pre-emergent fry, significantly diminishing the resulting ocean population and next generation of spawners. Additionally, stress caused by high water temperatures may reduce fish resistance to parasites, disease, and pollutants. Cold water is detrimental to the rapid growth of some juveniles. Since construction of Shasta Dam, water released in the spring was unusually too cold for this rapid growth of fall and late fall-run juvenile salmon. This was detrimental to the salmon because they must attain a length of about 70 millimeters and migrate downstream before temperatures in the lower Sacramento River and the Delta reach about 73 degrees.

Each of the above contributing factors are being addressed by various Federal, State, and local projects. They range from changing the timing and amount of reservoir releases to changing the temperature of released water. One of the operating parameters at Shasta was directed by the SWRCB and in the 1993 NMFS Biological Opinion (BO) for the Winter-run Salmon. This BO established surrogate flows in the river downstream from Keswick Dam primarily to effect water temperatures. Another important minimum flow assumption being used in operational studies for the surface water storage projects in the CALFED ROD includes implementing CVPIA (b)(2) based fish actions.

In addition to flow requirements, structural changes at Shasta Dam have been made to help better manage temperature needs to benefit anadromous fish populations in the upper Sacramento River. As mentioned, this consists of the Shasta Dam TCD that was completed in 1997. The TCD can draw water from the different levels of the lake, including the deepest, to help maintain a better temperature for salmon as well as running the water through the penstocks to produce power. The TCD is effective in helping to reduce Winter-run salmon mortality in some critically dry years and for Fall and Spring-run salmon in below normal years.

Likely conflicting with water temperature improvements made by the TCD at Shasta, is implementation of requirements contained in the Trinity River December 2000 ROD. As mentioned, one of the major features of the ROD is to reduce the average annual export of Trinity River water from 74 percent of the flow to 52 percent. This would result in a reduction of flows from the Trinity River Basin into Keswick Reservoir and then into the Sacramento River. Water diverted from the Trinity River is generally cooler than flows released from Shasta Dam. Accordingly, should the elements of the Trinity ROD be implemented, some of the benefits derived from the TCD will be offset by the reduction of the cooler water from the Trinity River.

Findings in the 2000-2001 Biennial Report of a California Department of Fish and Game Commission on the Sacramento River Winter-run Chinook Salmon indicate that the total number of fish are tending to be increasing. This is likely primarily due to minimum release requirements at Shasta Dam and to the TCD. However, there is still a residual need for generally cooler water in the Sacramento River especially in dry and critically dry years. This need for management of cooler water will increase should the Trinity River Decision be implemented.

WATER SUPPLY NEEDS

Demands for water in California exceed available supplies. As indicated in **Tables 10 and 11**, this need for additional supplies also exists in the Central Valley and is expected to continue. As the population of the Central Valley continues to grow, along with the needs to maintain a healthy and vibrant industrial and agricultural economy, the demand for adequate and reliable water supplies will become more acute. **Table 12** is a summary comparison of existing and expected future water use (2020 level demands) versus available supplies in the Sacramento River, San Joaquin River, and Tulare Lake Basins under drought year conditions from Bulletin 160-98. As shown, it is estimated that the demand for water in the future (2020 level demands) will exceeded available supplies in the Central Valley by at least 10 percent. In addition, based on the results of recent system modeling (CALSIM II), it is highly likely that the expected shortages will be greater than that shown in the table.

It is believed that the competition for available water supplies will intensify as water demands to support municipal, industrial, and related urban growth increase relative to agricultural uses. **Table 12** also shows the expected trend in the distribution of water supplies and water sources under drought year conditions from Bulletin 160-98 in the three basins. The data not only illustrates that although the current and projected shortages are significant, just as important is the understanding that much of the water required for new urban growth is projected to come from redirected agricultural uses.

TABLE 12
COMPARISON OF EXISTING AND FUTURE WATER USE VERSUS SUPPLIES IN THE CENTRAL VALLEY - DROUGHT YEAR CONDITIONS
(1,000 ACRE-FEET)

Water Condition	1995	2020	Comparison	
	Acre-Feet	Acre-Feet	Acre-Feet	Percent
Applied Water				
Urban	2,103	3,305	1,202	57
Agricultural	26,324	25,073	-1,251	-5
Environmental	6,936	6,957	21	0
Total	35,363	35,335	-28	0
Water Supply				
Surface Water	19,758	19,591	-167	-1
Groundwater	12,088	12,192	104	1
Recycled/Desalted	0	0	0	0
Total	31,846	31,783	-63	0
Shortage	***3,517***	***3,552***	***35***	***1***

Source: The California Water Plan, Bulletin 160-98, Appendix 6A, Regional Water Budgets with Existing Facilities and Programs, November 199, Sacramento River, San Joaquin River, and Tulare Lake Basins.

Various potential options are identified in Bulletin 160-98 to help meet expected future water shortages in the Central Valley. These options include construction of new dams and reservoirs consisting of new on-stream storage at the Parks Bar site on the Yuba River, Auburn Dam on the American River; and enlargements to Friant Dam on the Upper San Joaquin River, Pine Flat on the Kings River, and Lake Kaweah on the Kaweah River. It also identifies construction of offstream storage at the Waldo Reservoir Site near the Yuba River. Other measures expected to help meet future needs include ground water overdrafting, drought water marketing, and implementation of various CALFED programs. To date, however, with exception of possible new water storage on the Upper San Joaquin River, none of the new on-stream or offstream surface water storage projects appear likely to be implemented. Upper San Joaquin River (Friant Dam) is the only existing facility where a feasibility study is on-going. Significant additional efforts are underway in development of the 2003 Water Plan to identify potential reliable future water sources to help meet future needs.

Even with major efforts by multiple agencies to address the complex water resources issues in the State along with aggressive water conservation and increased water recycling and other water management measures, it is expected that demands will significantly exceed supplies. To avoid major impacts to the economy and overall environment of the State, it is believed that development of additional reliable water supplies is needed to meet future demands.

OTHER ENVIRONMENTAL OPPORTUNITIES

The health of the Sacramento River ecosystem as well as elsewhere in the Central Valley has been severely impacted in the last century by conflicts in the use of limited resources, particularly water resources. The result has been a decline in habitat and native species populations and a growing number of endangered and threatened species.

Construction of Shasta Dam has had both negative and positive effects on environmental resources in the region. Negative impacts of Shasta Dam include the blocking of historic fish migration into the upper watersheds of the Sacramento River, modification of seasonal flow patterns and the natural riverine processes that they support, and inundation of fish and wildlife habitat. However, the water resources within the reservoir also support a variety of environmental values and objectives throughout the Central Valley and Bay-Delta, playing a central role in environmental flow regulation and water quality. While construction of the dam displaced valuable riverine and upland habitat, it also created shoreline and shallow-water habitat for aquatic, terrestrial, and avian species. For example, Shasta Lake is home to the largest concentration of nesting bald eagles in California, with 18 pairs nesting within 0.5 miles of the shoreline in any given year.

Shasta Lake Area

Upstream from Shasta Dam within the lake, on adjacent lands, and in and near tributary streams natural resources have been impacted by various of activities. Probably the greatest impact has come from historic mining, ore processing practices, and acid mine drainage.

To guide the management of the Shasta-Trinity National Forest, the FS has prepared the Shasta-Trinity National Forest Land Resource Management Plan (STNFLRMP). Primary goals are to integrate a mix of management activities that allow use and protection of forest resources; meet the needs of guiding legislation; and address local, regional, and national issues. The STNFLRMP includes actions to implement management practices for increasing the amount of cover available for spawning and nursery habitat for warm-water fish in Shasta Lake and on its tributary streams. The STNFLRMP is also to guide implementation of the Aquatic Conservation Strategy of the Northwest Forest Plan for protection and management of riparian and aquatic habitats adjacent to Shasta Lake. The DFG has stocked Shasta Lake with Chinook salmon and rainbow trout to support the lakes cold water fisheries. Opportunities exist to further support the ongoing programs of the FS. These opportunities include improvement and restortion of environmental conditions by developing self–sustaining natural habitat in the Shasta Lake and tributaries area to benefit fish and wildlife resources.

Downstream From Shasta Dam

Land and water resources development has caused major resource problems and challenges. In addition to reduction in anadromous fish populations highlighted above, several others include reduction in riparian, wetland, floodplain, and shaded riverine habitat. This has resulted in reduced populations of many individual plant and animal species.

The quantity, quality, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine habitat along the Sacramento River has been severely limited by the confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development. The modification of seasonal flow patterns by dams and water diversions has also inhibited the natural channel-forming processes that drive riparian habitat succession. It is estimated that less than five percent of the historic acreage of riparian habitat within the Sacramento River Basin remains today.

Reduced quality and quantity of habitat has resulted in reduced population of many fish and wildlife species. Due to low populations and questionable sustainability of many species, listings under State and Federal endangered species acts have increased in recent years. Introduction of non-native species has also contributed to the decline in native animal and plant species. Lack of linear continuity of riparian habitats impact the movement of wildlife species among habitat patches, adversely affecting dispersal, migration, emigration and immigration. For many species, this has resulted in reduced wildlife numbers and population viability.

Ecosystem restoration along the Sacramento River has been the focus of several ongoing programs, including the CALFED Bay-Delta Program, SB 1086 Program, CVPIA, and the Central Valley Habitat Joint Venture. These and numerous local programs have been established in an effort to address the ongoing conflicts over the use of limited resources within the Central Valley. Much effort has been directed in the upper Sacramento River region toward restoring or improving anadromous fisheries, which provide recreational and commercial values in addition to their environmental value. Despite these efforts, there remains a significant need to restore and preserve ecosystem resources along the Sacramento River.

FLOOD PROBLEMS

Large and small communities, as well as agricultural lands, are under threat from flooding and the flood control issues are very complex. The Corps is conducting a comprehensive basin-wide study of flood management issues and options in the Sacramento River Basin, and continues to develop the Sacramento River Bank Protection Project and assist in local flood control projects along the Sacramento River.

Flooding poses risks to human life, health, and safety. Development in flood prone areas has exposed the public to the risk of flooding. While the existing flood management system has reduced the frequency that flooding occurs, large storms can result in river flows that exceed the capacity of the system or cause failures in the system. The January 1997 flood revealed flood management system problems including levee instability, insufficient conveyance capacity of many channels, and inefficiencies in flood management and warning programs and procedures. The threat to the public is caused by many factors. In particular, overtopping or sudden failures of levees can cause deep and rapid flooding with little warning, threatening lives and public safety.

Physical impacts from flooding occur to residential, agricultural, commercial, industrial, institutional, and public property. Damages occur to buildings, contents, automobiles, and outside property including agricultural crops, equipment, and landscaping. Physical damages include cleanup costs and costs to repair roads, bridges, sewers, power lines, and other infrastructure components. Nonphysical flood losses include income losses and cost of emergency services such as flood fighting and disaster relief.

Even though the Shasta Dam project has the potential to significantly control flood flows in the upper Sacramento River, there are influencing factors than can conflict with flood operation. Flood control operations at Shasta Dam, even with explicit rules provided in the flood control manual, are difficult to manage during a flood event. This is primarily due to the extreme inflow volumes to Shasta that can occur over long periods, numerous points of inflow along the river downstream from Shasta, and the multiple points of operational interest downstream. The primary downstream control point along the Sacramento River that determines reservoir releases under real-time operation is Bend Bridge. However, there are other un-official points of operation that are considered, such as peak flows at Hamilton City or other rural communities that are at risk of flooding.

These factors, combined with uncertainty of storm forecasting, can lead to staff exhaustion and, worse, loss of efficient control at Shasta Dam. Once this occurs, it could cause a domino effect on flood problems downstream to the Sacramento-San Joaquin Delta. Accordingly, there is recognized need for improved flood protection along the Sacramento River.

HYDROPOWER NEEDS

Were California a nation, it would be the 12th largest consumer of electricity, using roughly the same as South Korea and Italy. Among the 50 states, California is the second largest consumer of electricity. Although California has 12 percent of the nations' population, it only uses 7 percent of the electricity. This makes California the most energy efficient state per capita in the nation. Even so, the demands for electricity are growing at a rapid pace. As an example, over the next 10 years California's peak demand for electricity is expected to increase 30 percent from about 50,000 Mega-Watts (MW) to about 65,000 MW. There is, and will continue to be, increasing demands for new electrical energy supplies, including clean energy sources such as hydropower.

RECREATION NEEDS

As the population of the State continues to grow, there will be significant growing demands for water oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand will be especially pronounced at Shasta Lake. Any increase in the water surface area at the lake will likely provide opportunities to help meet future recreation demands.

CHAPTER V
PLAN FORMULATION APPROACH

PLAN FORMULATION RATIONAL

The fundamental plan formulation rationale being followed for the Shasta Lake Water Resources Investigation consists of:

- Identifying existing and projected future resource conditions without implementation of a project.
- Defining the water resources problems and needs to be addressed.
- Developing the planning objectives, constraints, and criteria, and an overarching Mission Statement.
- Formulating potential alternative plans to meet the study objectives.
- Comparing and evaluating the alternative plans.
- Selecting a plan for recommended implementation.

The strategy developed for this investigation has defined the above process in four basic phases. As can be seen in **Figure 5,** the four basic phases consist of:

- **Mission Statement Phase –** Identify without-project future conditions, define resulting resources problems and opportunities, define a specific set of planning objectives, identify the constraints and criteria in addressing the planning objectives, and develop a concise mission statement based on the study objectives.
- **Initial Plans Phase –** Identify potential resource management measures to address the study objectives and formulate, coordinate, and compare an initial set of potential alternative plans.
- **Alternative Plans Phase –** From the initial plans, formulate specific alternative plans to address the planning objectives; evaluate, coordinate, and compare the plans; and identify a plan for tentative recommendation.
- **Recommended Plan Phase –** Complete development of a tentatively recommended plan and prepare, coordinate, and process supporting decision documentation.

A summary of existing and potential future without-project conditions and problems and needs (similar to the NEPA Baseline) is included in Chapters III and IV. Following are the identified planning objectives, constraints, criteria, and Mission Statement.

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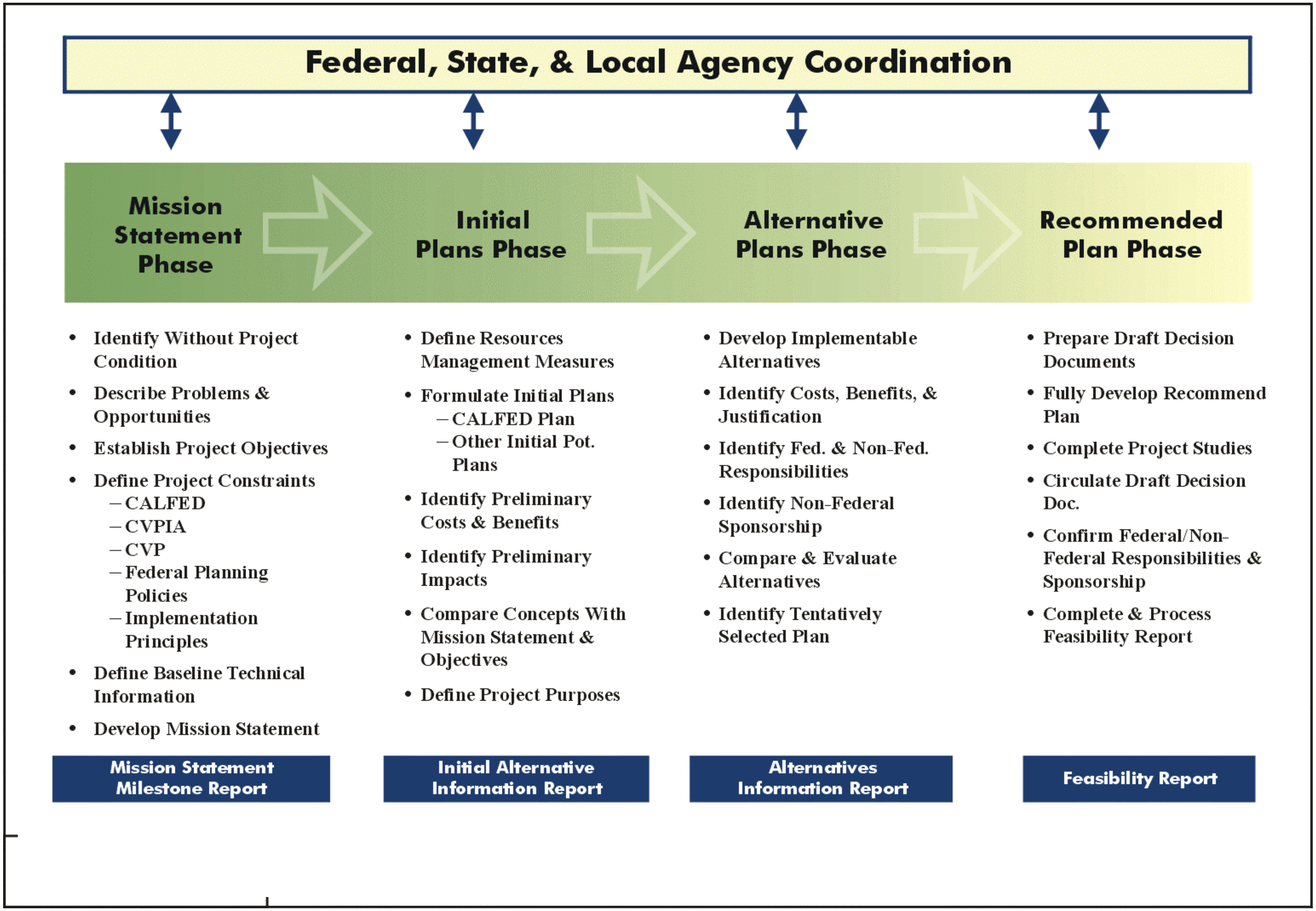

Figure 5 – Plan Formulation Process

PLANNING OBJECTIVES

On the basis of the previously identified and defined problems and needs in the study area and in relation to the study authorities, the following planning objectives were developed. These objectives are to be used to help guide the formulation of alternatives to address the problems and needs. They are separated into primary and secondary objectives. Primary objectives are those for which specific alternatives would be formulated to address. Secondary objectives are opportunities that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

- **Primary Objectives –**

    - Increase the survival of anadromous fish populations in the Sacramento River primarily upstream from the RBDD.

    - Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes to the CVP to help meet future water demands with a primary focus on modification of Shasta Dam and Reservoir.

- **Secondary Objectives –** To the extent possible through pursuit of the primary planning objectives, include as opportunities, features to help:

    - Preserve and restore ecosystem resources in the Shasta Lake area and long the upper Sacramento River.

    - Reduce flood damages along the Sacramento River.

    - Develop additional hydropower capabilities at Shasta Dam.

    - Provide additional water-related recreational opportunities in the Shasta Lake area.

PLANNING CONDITIONS

Constraints

Fundamental to the plan formulation process is the identification and development of basic constraints specific to this investigation and general criteria to be used to help compare and evaluate alternative plans. Planning constraints include Congressional direction; current applicable laws, regulations, and policies; guiding principals specific to the investigation; and existing water resource projects and programs such as CALFED and CVPIA. Several major constraints in formulating and ultimately implementing a plan to meet study objectives are as follows:

- **Study Authorization –** The fundamental authority for this investigation is described in Chapter I. Basically, the authorization provides for an investigation of the potential benefits for enlarging or replacing Shasta Dam and Reservoir.

- **Laws, Regulations, and Policies –** Numerous laws, regulations, Executive Orders, and policies need to be considered, including the NEPA, Fish and Wildlife Coordination Act, Clean Air Act, Clean Water Act, ESA, CEQA, and the CVPIA.

- **CALFED ROD –** The CALFED ROD includes program goals, objectives, and projects primarily to benefit the Sacramento/San Joaquin Bay-Delta System. The ROD has been adopted by various State and Federal agencies for further consideration. In addition to enlarging Shasta Reservoir, the PPA includes four other surface water storage projects and groundwater storage projects to help reduce the discrepancy between water supplies and projected demands. The program also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta System. Developed plans should be cognizant of the goals, objectives, and programs/projects of the CALFED ROD.

Guiding Principals

The following are fundamental principals intended to help guide development of solutions to the identified problems. They are based primarily on local, project-specific conditions including consideration of ongoing projects and programs.

- All alternative plans considered should address each of the identified primary planning objectives and, to the extent possible, the secondary planning objectives.

- Primary consideration should be given to recommendations in the CALFED ROD with at least one of the alternatives developed, or major element of an alternative, being the enlargement of Shasta Lake by approximately 300,000 acre-feet feet through raising Shasta Dam 6.5 feet.

- Measures and alternatives to address the planning objectives should consider:

  - Enhancing water management flexibility in the Sacramento Valley to facilitate changing diversion patterns during critical fish migration periods.

  - Providing opportunities for enhancing water management programs.

  - Including opportunities for conjunctive use including groundwater banking and storage in offstream surface water storage reservoirs.

  - Avoiding any reduction in flood control or hydraulic impacts to the areas downstream on the Sacramento River.

  - Minimizing the need for environmental mitigation associated with plan components through enhanced designs and construction methods.

  - Not precluding nor enhancing the potential for development of other elements of CALFED or other ongoing projects and programs.

Criteria

Potential alternative plans would need to be measured against several primary criteria, including those presented in the Federal Water Resources Council's *Principles and Guidelines*. The most significant criteria applicable to development of alternatives and plan selection are:

- **Completeness –** Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure realization of planned effects.

- **Effectiveness –** Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified objectives.

- **Efficiency –** Efficiency is the measure to which a plan is the most cost-effective means of alleviating the identified problems while realizing the specified objectives. One measure of efficiency is monetary costs versus benefits. Another measure includes contributions to ecosystem restoration.

- **Acceptability –** Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local governments and the public and compatibility with existing laws, regulations, and public policies. This includes a requirement for a non-Federal sponsor to share in the implementation cost for a potential project modification.

MISSION STATEMENT

On the basis of the identified problems and needs, primary and secondary planning objectives, relationship to other programs and projects, and Federal planning guidance, the following draft Mission Statement was developed.

> ***"To develop an implementable plan primarily involving the modification of Shasta Dam and Reservoir to promote increased survival of anadromous fish populations in the upper Sacramento River; increased water supply reliability to the Central Valley Project; and to the extent possible through meeting these objectives, include features to benefit other identified ecosystem, flood control, and related water resources needs."***

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CHAPTER VI
POTENTIAL INITIAL PLANS

RESOURCE MANAGEMENT MEASURES

Following development of the planning objectives, constraints, and criteria for the study, the next major step in formulating alternative plans is to identify potential resource management measures. A resource management measure is any structural or non-structural action that could address the study objectives. Alternative plans are formulated by combining the most applicable management measures.

An initial list of potential resource management measures to address the planning objectives listed in Chapter V and an indication of the relative application of the measures to the planning objectives are highlighted in **Table 13**. Additional efforts to identify and evaluate management measures will occur in the Initial Plans Phase (see **Figure 5**) and will be described in the Initial Alternatives Information Report.

Primary Planning Objectives

Following are potential measures to address the primary planning objectives.

Water Supply Reliability

"Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes in the CVP to help meet future water demands with a primary focus on modification of Shasta Dam and Reservoir."

- **Increase the conservation storage space in Shasta Reservoir by raising Shasta Dam** – This measure consists of increasing the amount of available space for conservation storage in Shasta Lake through raising Shasta Dam and thereby enlarging Shasta Reservoir. Various raises have been considered by previous studies. A raise of 6.5-feet is included in the PPA for the CALFED ROD. Previous studies also looked at raising the dam from about 30 feet to over 200 feet.

Included in **Plate 6** are estimates of the relative increases in storage capacity and water surface area for dam raises up to about 200 feet. **Plate 13** is a plan view of Shasta Reservoir showing the relative increase in inundation area for raises of 100 and 200 feet. A 6.5 foot raise would result in an estimated 290,000 acre-feet of additional storage space with an increase in surface area inundated at gross pool from about 29,500 acres to about 30,200 acres. The enlarged space would help increase water supply reliability by adding over 70,000 acre-feet per year to the yield of the CVP. A 200-foot raise would result in an estimated 9.1 MAF of storage space in Shasta Reservoir and cover an area at gross pool of about 60,000 acres.

Raising Shasta Dam directly contributes to the primary planning objective and previous studies have indicated that raising the dam is technically feasible. It is believed therefore, that this measure should be retained for further development. However, for consistency with the planning constraints and criteria, and to be more consistent with recommendations in the CALFED ROD, emphasis should be placed on smaller dam raises.

TABLE 13
POTENTIAL RESOURCE MANAGEMENT MEASURES

Planning Objective		Potential Resource Management Measure	Potential to Address Planning Objective
Primary Objectives	Water Supply Reliability	Increase the conservation storage space in Shasta Reservoir by raising Shasta Dam.	Very high – Raising dam directly contributes to increased water supply reliability.
		Increase the conservation pool in Shasta Reservoir by encroaching on dam freeboard.	Very low – Very limited potential to encroach on existing freeboard above gross pool which is only 9.5 feet.
		Increase the conservation storage space in Shasta Reservoir by reallocating space from flood control.	Very low –Very low potential for implementation due to high resulting adverse impacts on flood control accomplishments.
		Increase the effective conservation storage space in Shasta Reservoir by increasing the efficiency of reservoir operation for water supply reliability.	Low to moderate – Some potential for increased water supply reliability and for operational efficiency for flood control but reduced likelihood for implementation due to perceived adverse impacts to flood control.
		Construct new conservation storage reservoir(s) upstream from Shasta Lake.	Very low – Upstream storage sites capable of CVP system-wide benefits would be very costly, result in environmental impacts difficult to mitigate, likely not be supported by local interests, and be inconsistent with the CALFED ROD.
		Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam.	Very low – Although potentially feasible sites/projects exist to significantly increase water supply, there are significant overriding environmental issues restricting implementation at this time.
		Construct new conservation offstream surface storage near the Sacramento River downstream from Shasta Dam.	Moderate – Although not as effective as additional storage at Shasta, significant potential for conjunctively using releases from Shasta in new surface water facility to enhance system yield.
		Construct new conservation surface water storage south of the Sacramento-San Joaquin River Delta	Low – Not viewed as an alternative to additional storage at Shasta. Independent feasibility scope studies are being initiated under PL 108-7.
		Develop new conservation groundwater storage near the Sacramento River downstream from Shasta Dam.	Moderate – Similar to offstream storage. When combined with new storage at Shasta, potential to enhance system yield depending on availability of groundwater storage sites.
		Develop additional conservation groundwater storage south of the Sacramento-San Joaquin River Delta.	Low –When combined with new storage at Shasta, limited potential to enhance system yield depending on availability of groundwater storage sites.
		Increase total or seasonal conservation storage at other CVP facilities.	Very low – Not a substitute for additional storage at Shasta.
		Implement additional demand management programs.	Low – Not a substitute for additional storage at Shasta, but potential for inclusion in an alternative plan.

TABLE 13 (CONTINUED)
POTENTIAL RESOURCE MANAGEMENT MEASURES

Planning Objective		Potential Resource Management Measure	Potential to Address Planning Objective
Primary Objectives	Anadromous Fish Survival	Further modify the outlets at Shasta Dam to release cooler water during critical spawning periods.	Moderate to High – Although existing temperature control device at Shasta effectively meets objectives, potential exists to further modify the device to benefit anadromous fish. Potential effectiveness increases with increase in storage at Shasta.
		Create shaded riverine habitat at critical locations along Sacramento River downstream from Shasta Dam	Moderate to High – Significant potential to help contribute to restoration of primarily fish habitat in upper Sacramento River.
Secondary Objectives	Other Environmental Opportunities	Restore of warm and cold water fisheries through creation of riverine habitat along lower reaches of major tributaries to Shasta Reservoir.	Moderate to High – Significant potential to help restore fish habitat at critical locations near reservoir and creek/river interface.
		Create riparian and wetland resources at critical locations along lower reaches of major tributaries to Shasta Reservoir.	High – Strong potential to help restore wildlife habitat at critical locations near reservoir and creek/river interface.
		Create riparian, wetland, and upland habitat at critical locations along the Sacramento River downstream from Shasta Dam.	Moderate to High – Significant potential to help contribute to restoration of primarily wildlife habitat in upper Sacramento River.
	Flood Damage Reduction	Increase flood control storage space in Shasta.	Low – Estimated low net economic flood damage reduction benefits due to relatively high cost related to raising the dam or reducing water supply benefits.
		Increase the conservation storage space in Shasta Reservoir by reoperating the reservoir.	Moderate – Potential to marginally increase flood damage reduction accomplishments of Shasta under both existing space allocations or in conjunction with increased conservation space through revising of reservoir operation rules for flood control.
		Increase flood control operation effectiveness of Shasta Dam and Reservoir during a flood event.	Moderate to High – Significant potential to enhance real-time flood control operations at Shasta both at current or expanded size.
	Hydro-power	Increase hydropower generation at Shasta Dam.	Moderate – Potential to realize some increase in hydropower output from Shasta with increased sizes of Shasta Reservoir.
	Recreation	Increase recreation opportunities in Shasta Reservoir.	Moderate – Potential to realize some increase in recreation resources in and near Shasta Reservoir with increased sizes of Shasta Reservoir.

- **Increase the conservation pool in Shasta Reservoir by encroaching on dam freeboard** – This measure consists of increasing the conservation storage space in Shasta by raising the gross pool elevation without raising Shasta Dam. The current gross pool elevation at Shasta is 1,067 feet (msl) and the top of dam elevation is approximately 1,076.5 feet. Accordingly, the design freeboard above maximum water surface elevation is 9.5 feet. It is estimated that major modifications would be required at the dam and appurtenances to allow operational encroachments into the design freeboard of the dam, only to gain a fairly small potential increase in reservoir storage. Consequently, there is a low potential for this measure to effectively address the planning objective and it is likely to be found that this measure should be deleted from further consideration.

- **Increase the conservation storage space in Shasta Reservoir by reallocating space from flood control** – This measure consists of decreasing the maximum seasonal flood control storage space in Shasta Reservoir and dedicating that space to conservation water supply. The maximum seasonal flood control storage space in Shasta is 1.3 MAF from 1 December through 20 March depending on accumulated seasonal inflow volumes. Reducing the seasonal flood control storage space would reduce the ability of the reservoir to control peak flood flow releases. This would result in an increase in the frequency of flooding and flood damages along the Sacramento River downstream from Shasta Dam.

It is estimated that there is very low potential for implementing this measure due to the adverse impact to the flood control accomplishments of the existing facility and potentially costly mitigation for increases in downstream flood damages. Because of this, it is likely to be found that this measure should be deleted from further consideration.

- **Increase the effective conservation storage space in Shasta Reservoir by increasing the efficiency of reservoir operations to benefit water supply reliability** – This measure consists of changing the flood control operations of Shasta Dam and Reservoir (without reducing the flood pool) with a goal to increase water supply reliability. This measure would focus on revising the operation rules for flood control such that the facility could potentially be managed more efficiently for flood control, thereby vacating some seasonal storage space for water supply. A primary constraint would be no adverse impact to the existing level of flood protection provided by the Shasta Dam project. It is believed that some amount of efficiency could be gained through a critical assessment of reservoir operations using more current analytical and weather forecasting tools.

It is also believed that although the potential for increased water supply reliability through reoperation efficiencies for flood control would likely be small, this measure should be carried forward for more detailed consideration for possible inclusion in alternative plans.

- **Construct new conservation storage reservoir(s) upstream from Shasta Lake** – This measure consists of constructing dams and reservoirs at various locations upstream from Shasta Lake, primarily for increased water conservation storage and operational flexibility. Numerous reservoir storage projects have been considered and many constructed in the watershed upstream from Shasta Lake. Three sites that have held the most promise were also identified in the Initial Surface Water Storage Screening Report (August 2000) prepared for CALFED. They included

Allen Camp Reservoir at about 180,000 acre-feet on the Pit River in Modoc County, Kosk Reservoir at about 800,000 acre-feet on the Pit River in Shasta County, and Squaw Valley Reservoir at 400,000 acre-feet on Squaw Valley Creek in Shasta County. Other potential sites have been considered in previous studies.

The Allen Camp Reservoir site was eliminated from further consideration at this time because it is relatively small and has a very limited potential for increased water supply to the CVP. The other two reservoir sites, Kosk and Squaw Valley reservoirs, were eliminated from further consideration primarily because they would not be consistent with screening criteria established in the CALFED Integrated Storage Investigations, would likely not be supported in the local area because the water would need to be developed for CVP system reliability (not retained for local use), and would result in a relatively high unit water cost to implement (over $800 per acre-foot).

- **Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam** – Various on-stream reservoir storage projects along tributaries to the Sacramento River downstream from Shasta Dam were considered in the CALFED Initial Surface Water Storage Screening Report. These and other potential surface water reservoir sites have also been considered as part of numerous other studies over the years. Several projects having the potential to significantly contribute to increasing water supply reliability is the Cottonwood Creek Project (1.6 MAF on Cottonwood Creek north of Red Bluff), the Auburn Dam Project (2.3 MAF on the middle fork of the American River near Sacramento), and the Marysville Lake Project (920,000 acre-feet on the Yuba River near Marysville). Although each project would likely be economically feasible given the estimated future need for new water supplies, and each would include mitigation features to offset potential adverse environmental impacts, they have been rejected by state and local interests as potential candidates for new water sources. Each was eliminated from further consideration by CALFED primarily because of potential adverse environmental impacts. It is likely to be found that this measure should be removed from further consideration due to significant overriding environmental issues restricting implementation at this time.

- **Construct new conservation offstream surface storage near the Sacramento River downstream from Shasta Dam** - Various offstream reservoir storage projects were considered in the CALFED Initial Surface Water Storage Screening Report. All but one were eliminated from further consideration in the CALFED ROD primarily due to project cost considerations, potential environmental impacts, and lands and relocation issues. The one project that was retained for initial consideration was Sites Reservoir (a.k.a. NODOS). As initially conceived, the reservoir would have a storage capacity of up to 1.9 MAF. The reservoir would be filled primarily by through water diverted from the Sacramento River and most likely pumped to the reservoir through Tehama Colusa Canal during periods of excess flows in the river. Further development of NODOS Project and appurtenances are being accomplished primarily under the leadership of the DWR.

Although NODOS has a potential to help increase water supplies to the CVP and/or SWP, it is believed that this measure is not a substitute for enlarging Shasta Dam and Reservoir, as initial cost estimates indicate that a Shasta enlargement is more cost efficient. However, there is a significant potential for conjunctively using some of the water supply from Shasta, especially during average and wet years, in an offstream storage reservoir. Accordingly, it is believed that offstream storage as a potential adjunct to raising Shasta Dam should be considered further in the plan formulation process.

- **Construct new conservation surface water storage south of the Sacramento-San Joaquin River Delta** – A relatively large portion of the CVP's future water needs are in service areas in the San Joaquin River Basin, south of the Delta. In addition, there will continue to be large demands, primarily on the SWP, to provide water for M&I purposes further south via the California Aqueduct and for increased water supply reliability to the South Bay areas. A portion of these demands could be provided from on-stream and/or offstream surface water storage within the San Joaquin River Basin. Numerous surface water storage sites have been identified in the past along the east side and west side of the San Joaquin Valley and in areas to the west of the Delta near Stockton.

On-stream storage sites are exclusively located on the east side of the valley due to the lack of significant annual runoff from the Coast Mountain Range. Several potential on-stream storage sites could include enlarging Pardee Reservoir on the Mokelumne River, enlarging and modifying Farmington Dam on Littlejohns Creek, and enlarging Friant Dam on the upper San Joaquin River. Through the CALFED Program, numerous potential offstream storage sites were also considered in the San Joaquin Valley. Several sites were on the east side of the valley and were conceived to receive diverted flows from nearby rivers, but most of the sites were adjacent to the California Aqueduct and would receive pumped water from the aqueduct during periods of excess flows.

As mentioned, one of the CALFED surface water projects authorized for feasibility scope investigation in Section 215 of PL 108-7 is the Upper San Joaquin River Storage Investigation. This study will further assess potential surface water storage measures primarily along the San Joaquin River and its tributaries.

- **Develop conservation groundwater storage near the Sacramento River downstream from Shasta Dam –** This measure consists of developing groundwater recharge projects near the Sacramento River. This would include pumping and using groundwater during dry periods, and diverting excess Sacramento River flows and recharging depleted groundwater basins during wetter periods.

As with offstream storage discussed above, it is believed that this measure has the potential to allow all or a portion of an increase in storage from a modification of Shasta to be temporally stored in groundwater basins along the Sacramento River for later use during critical dry periods. It is likely that this measure will be retained for further development and consideration.

- **Develop additional conservation groundwater storage South of the Sacramento-San Joaquin River Delta –** This measure consists of either developing new groundwater recharge projects south of the Delta or contributing to existing recharge projects. It would include diverting flows during periods of excess from the San Joaquin River or from the Delta Mendota Canal or California Aqueduct and helping recharge depleted ground water basins. Although limited, it is believed that this measure could have a potential to allow for a portion of an increase in storage from a modification of Shasta to be temporally stored south of the Delta for later use during critical dry periods.

- **Increase total or seasonal conservation storage at other CVP facilities –** This measure consists of increasing the conservation storage space in other major CVP or SWP reservoirs in the Sacramento River Watershed. Several potential project expansions were considered in the CALFED Initial Surface Water Storage Screening Report. Besides Shasta Dam and Reservoir, this included additional storage in facilities such as Lake Berryessa on Putah Creek, Folsom Reservoir on the American River, Trinity Lake on the Trinity River, and Lake Oroville on the Feather River. It is believed that, of the existing reservoirs in the CVP/SWP systems, modifications to Shasta would be the most cost effective. Because of this, it is believed that this measure should be removed from further consideration.

- **Implement additional demand management programs –** This measure consists of reducing the demand to the CVP. This could include concepts such as increased water conservation, removing lands from agricultural production, increasing the price paid by CVP customers, and restricting urban growth in the Central Valley through regulatory practices. Various ongoing programs primarily as part of CVPIA and CALFED are focused on demand management measures. There is a potential for at least some of the measures to be further considered in the plan formulation process.

Anadromous Fish Survival

"Increase the survival of anadromous fish populations in the Sacramento River primarily upstream from the RBDD."

- **Further modify the outlets at Shasta Dam to release cooler water during critical spawning periods –** This measure consists of further modifying the outlet works at Shasta Dam to better control the temperature of outflows. The existing TCD at Shasta is a multi-level water intake structure located on the upstream face of the dam. By drawing water from the top of the reservoir during the winter and spring when the surface water temperatures are cool, and from deep in the reservoir in the summer and fall when the surface water is warm, Reclamation is able to fulfill most contractual obligations for both water delivery and power generation while benefiting downstream fisheries. There may be a potential to further modify the existing TCD to benefit anadromous fish survival. This potential would be enhanced with any enlargement of Shasta Dam and Reservoir.

- **Create shaded riverine habitat at critical locations along Sacramento River downstream from Shasta Dam –** This measure consists of identifying locations along the Sacramento River from Shasta Dam downstream to about Red Bluff where creation of additional shaded riverine habitat could be beneficial primarily for anadromous fish. This measure could include acquiring specific riverbank areas and planting these locations with native vegetation to create the shaded habitat and managing the area over time. It could also include gravel replacement, introduction of woody debris, and other habitat improvements. It is believed that this measure could be most applicable when coupled with ongoing efforts by local conservation groups and consistent with ongoing efforts of CALFED.

Secondary Planning Objectives

Following are several potential measures identified to address the secondary planning objectives.

Other Environmental Opportunities

"Preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River."

- **Restore warm and cold water fish through creation of in-stream riverine habitat along the lower reaches of major tributaries to Shasta Reservoir –** This measure consists of identifying locations along the lower reaches of major tributaries to Shasta Lake where there are opportunities to create or improve instream habitat beneficial to warm and cold water fish species. This measure could include planting shaded riverine habitat, constructing/placing fish habitat devices within the stream environment, and constructing/refurbishing fish spawning beds. Primary areas of opportunity would be along the upper Sacramento River, McCloud River, Squaw Creek, and Pit River. It is believed that this measure would be most applicable when coupled with ongoing efforts by local conservation groups.

- **Create riparian and wetland resources at critical locations along lower reaches of major tributaries to Shasta Reservoir –** This measure is similar to the one above except it consists of creating the riparian, wetland, and related wildlife habitat along the lower reaches of major tributaries to Shasta Lake. There are believed to be numerous opportunities along the upper Sacramento River, McCloud River, Squaw Creek, and Pit River to implement this measure. It is believed that this measure would be most applicable when coupled with ongoing efforts by local conservation groups.

- **Create riparian, wetland, and upland habitat at critical locations along the Sacramento River downstream from Shasta Dam –** This measure consists of creating healthy riparian, wetland, and upland vegetation communities at opportunity locations along the Sacramento River from Shasta Dam to about Red Bluff. It could also include tributary streams and locations where urban development is encroaching on the river. As with the above ecosystem restoration measures, it is believed that this measure would be most applicable when coupled with ongoing efforts by local conservation groups and consistent with ongoing efforts of CALFED.

Flood Damage Reduction

"Reduce flood damage along the Sacramento River."

- **Increase flood control storage space in Shasta –** This measure consists of increasing the flood control storage space in Shasta Reservoir primarily through raising the dam or reducing water conservation storage space. Both measures, however, would generally conflict with the primary planning objectives. A variation would be to substitute water conservation storage space in Shasta with storage in another reservoir, such as the NODOS Project, and use the vacant seasonal space in Shasta for increased flood control. However, it is believed that the potential flood damage reduction benefits to be gained would be far less than the costs to create the increased storage space either in Shasta Reservoir or other facilities. Accordingly, it is likely that this measure will be removed from further consideration.

- **Increase the conservation storage space in Shasta Reservoir by reoperating the reservoir –** This measure consists of revising the established rules for operating Shasta Dam and Reservoir primarily for flood control. It would include reassessing the operation rules for flood control and determining if there is a potential to use updated hydrology, currently available mathematical modeling tools, and state-of-the-art weather forecasting technology to increase the effectiveness of Shasta in reducing the frequency of downstream floodflows. Because this measure would not adversely impact the other study objectives and may even help advance the objectives, it is believed that it should be retained for further evaluation.

- **Increase flood control operation effectiveness of Shasta Dam and Reservoir during a flood event –** Flood control operations at Shasta Dam during a flood event, even with explicit rules provided in the flood control manual, are very difficult to manage for extended periods. This measure consists of developing an enhanced real-time flood flow prediction system. This could include adding additional stream gages to better estimate inflows into Shasta and into the Sacramento River downstream of Keswick Dam. It also could include an enhanced rainfall forecasting system to better predict runoff and plan for pre-flood releases. Other features could include modifications to the flood control manual to aid in real-time operation. It is believed that this measure has the potential to improve flood operations at Shasta and help reduce the risk of catastrophic flooding along the lower Sacramento River. Accordingly, this measure should be retained for further evaluation.

Hydropower

"Develop additional hydropower capabilities at Shasta Dam."

- **Increase hydropower generation at Shasta Dam –** This measure consists of modifying the hydropower generation facilities at Shasta Dam to take advantage of any increases in water surface elevations resulting from enlarging the dam, if applicable. This measure should be part of any plan considered that includes a modification of Shasta Dam.

Recreation

"Provide additional water-related recreational opportunities in the Shasta Lake area."

- **Increase recreation opportunities in Shasta Reservoir –** This measure consists of modifying the recreation and related facilities in Shasta Reservoir to take advantage of any increases in seasonal water surface area, if applicable. This measure should be part of any plan considered that includes a modification to Shasta Reservoir storage space.

CONCEPT PLANS

During the next phase of the study, the above management measures will be further developed and others will be identified. Alternative plans will then be formulated considering the planning objectives, constraints, principles, and criteria described in Chapter V. However, for discussion purposes as part of this interim report, general concept plans were developed to highlight the range in possible alternatives from those measures above believed to best address the planning objectives. Many combinations of measures are possible. Again, formulation of alternative plans will be the primary focus of further study efforts.

Concept Plan Identification

Following is a brief description of preliminary concept plans that capture a range of formulation scenarios and strategies.

- **Enlarge Shasta - Low Option Concept –** This concept is primarily the plan suggested in the CALFED ROD. Its main feature consists of enlarging Shasta Reservoir by 290,000 acre-feet through raising the dam 6.5 feet. The concept could incorporate ecosystem restoration through establishment or expansion of existing riverine, riparian, and wetland resources at available locations not yet identified around Shasta Lake and along the Sacramento River upstream from Red Bluff. It is estimated that the plan would improve the water supply reliability in the CVP system by increasing the average annual supplies by about 70,000 acre-feet per year with about 80 percent of this yield to areas south of the Delta. It would also provide for an enlarged cold water pool at Shasta, allowing added flexibility to benefit downstream anadromous fish. This concept would not require major relocations to Shasta area facilities. It would increase the inundated area at gross pool by about 700 acres. Infrequent inundation would extend upstream on the McCloud and Pit rivers an estimated 1,400 feet and 1,700 feet at gross pool, respectively. This concept would represent a low raise option within the range of potential dam raises identified previously.

- **Enlarge Shasta – Expanded Option Concept –** This concept consists of increasing the water supply reliability to the CVP and cold water pool at Shasta by enlarging Shasta Dam and Reservoir an amount significantly larger than suggested in the CALFED ROD. In addition to benefiting the cold water pool in Shasta Reservoir for downstream anadromous fish, it would help restore ecosystem values through establishment or expansion of existing riverine, riparian, and wetland resources at available locations not yet identified around Shasta Lake and along the Sacramento River upstream from Red Bluff.

As mentioned, previous studies have estimated that dam raises up to about 200 feet are physically feasible. However, such raises would double the aerial extent of inundation at gross pool causing significant environmental concern and displacement of area facilities and residents. It would require relocating a major railroad, Interstate 5, numerous smaller roads and bridges, several small community centers, and all recreation facilities currently along the lake shore. As the study progresses, this concept would likely consist of enlarging Shasta Dam and Reservoir by an amount limited by these major relocations, less than about 20 to 30 feet.

- **Conjunctive Use Concept –** The major components of this concept consists of (1) enlarging Shasta Reservoir about 290,000 acre-feet by raising the dam 6.5 feet, (2) developing a conjunctive use storage area, and (3) constructing ecosystem restoration features near Shasta Reservoir and along the upper Sacramento River. The Shasta Dam and Reservoir modifications and ecosystem restoration components would be similar to those highlighted above.

The purpose of the conjunctive use storage area component of this concept could be to enhance the ability for long-term carry over storage, which could increase the reliability of critical dry period supply in the CVP. Conjunctive use consideration would include storage in either groundwater or in new or existing offstream surface water storage facilities.

- **Non-Structural Concept –** This concept primarily consists of reoperating Shasta Dam and Reservoir for increased water supply reliability and increasing the real-time flood control operation reliability of Shasta Dam. This could include enhancing the use of long range weather forecasting to modify the maximum seasonal drawdown for flood control and potentially allow earlier fill periods in the spring.

For improving real-time flood operations, this could include expanding the network of telemetered precipitation and streamflow gages in the upper watershed and on tributary watersheds to the upper Sacramento River. Also included would be enhanced real-time streamflow prediction capabilities at important decision points along the Sacramento River. This concept would require minimal physical changes and have minimal adverse environmental impacts.

- **Multiple Interest Concept –** The major components of this concept includes a combination of the following:

  - Enlarging Shasta Reservoir between about 290,000 and acre-feet 1 MAF by raising the dam between about 6.5 feet and 30 feet.

  - Developing a groundwater or offstream surface water storage area for carryover storage into dry years.

  - Reoperating Shasta Dam and Reservoir for increased water supply reliability.

  - Increasing the real-time flood control operation reliability of Shasta Dam.

  - Constructing ecosystem restoration features near Shasta Reservoir and along the upper Sacramento River.

Potential features to address other secondary planning objectives for additional recreation and hydropower opportunities at Shasta Dam and Reservoir could be considered in a multiple interest concept.

Continued Formulation

Of those measures that are determined to be most applicable in meeting the identified planning objectives, constraints, and criteria, there are numerous combinations that might form alternative plans. As mentioned, the concepts identified represent a range of potential variations and combinations of resource measures. It will be the focus of studies for the Initial Alternatives Information Report to refine the management measures and more completely define and evaluate initial alternatives for consideration in the remainder of the feasibility study.

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CHAPTER VII
STUDY MANAGEMENT AND PUBLIC INVOLVEMENT

STUDY MANAGEMENT

Reclamation has established a study management structure consisting of a Study Management Team (SMT) and Project Coordination Team (PCT). Following is a summary of the responsibilities for each team.

- **Study Management Team –** The SMT consists of participating agency individuals at the management and/or policy level. Each team member is responsible for ensuring that all PCT members are provided sufficient resources and direction to complete the various tasks assigned. The SMT provides overall guidance for the study ensuring participating agency views are addressed. The Project Manager participates in the SMT by providing administrative and technical focus information and adequate communication between the two teams.

- **Project Coordination Team –** The PCT consists at minimum, of the Project Manager, an environmental specialist, a fisheries biologist, an archeologist, a public affairs specialist, a design engineer, a hydrologist, and an economist. A representative on the team from the FWS is to help assist in study coordination. At the PCT meetings, each study component is to be adequately represented by the varied backgrounds of team members. Participation in team meetings is subject to the topic discussed, and additional expertise is included as necessary. The PCT directs the work performed by Technical Work Groups and coordinates the results into the overall study. The PCT team also directs public involvement activities and coordinates general public input into the study.

In addition to the SMT and PCT, several other teams and work groups have and are being established to assist in accomplishing the study. They include Technical Work Groups and various stakeholder groups including (1) Area Impact and Restoration Communication Teams (AIR Com Team), (2) Water Supply and Reliability Communication Teams (WSR Com Team), and (3) Tribal Communication (Tribal Com). The Technical Work Groups consist of working groups focusing on specific study areas such as designs and costs, environmental studies, plan formulation, hydrologic and hydraulic modeling. These work groups consist of an appropriate combination of contractors and Reclamation employees.

PUBLIC INVOLVEMENT PLAN

The Strategic Agency and Public Involvement Plan (Plan) for the Shasta Lake Water Resources Investigation has been designed to act as a manual to assist the PCT ineffectively communicating with those individuals, groups and agencies that are affected by or can benefit from enlargement or modification of Shasta Dam. It is anticipated that the Plan will be amended as the project evolves. A description of the Plan is contained in Appendix C and is highlighted below.

The Plan is to provide a system where the following five objectives are met:

- **Stakeholder Identification –** This effort will research, identify, and qualify those individuals, groups, and other entities that have an expressed or implied interest in enlargement and/or operation modification of Shasta Dam. No individual, group, or entity is to be excluded from the process, which includes meeting Executive Order 12898: "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." Efforts to identify additional stakeholders will be maintained throughout the investigation by outreach efforts with known stakeholders and the application of technologies such as the Internet.

- **Project Transparency –** Success of the investigation will rely on project transparency, a practice where the activities and study results are provided to stakeholders in a timely, unbiased fashion. Distribution of this information is a vital goal for the project team. By building and maintaining a reservoir of goodwill, the PCT will be better equipped to weather potentially unpopular measures developed during the investigation. Distributing this information will take many forms, in part, including: the media, the Web, public meetings, stakeholder meetings, and public presentations.

- **Issues and Concerns Resolution –** Equally important as project transparency is gaining awareness of the issues and concerns of the stakeholders and establishing a mechanism where the PCT can learn of these problems early. Using various public involvement processes, the PCT will address issues and concerns it discovers in an effective and timely manner. Priority will be given to finding solutions through consensus with stakeholders. If consensus is not achievable, solutions will be sought through stakeholder consent, consistent with the study objectives and mission statement.

- **Sponsor Identification –** As a collective effort, the agency and public involvement program builds synergies that contribute to successful completion of the investigation. Through these synergies, potential sponsor(s) for implementation of enlargement and/or operational modifications of Shasta Dam will emerge. These sponsors may either rise from the stakeholder group itself, or by referral within the stakeholder community.

- **Project Implementation –** An implementable project will need to meet the primary planning objectives. One goal of the Plan is to build a communication network where policy-makers understand the project purpose and benefits of the project and conclude for themselves that the project has met all requirements necessary to be implemented. This will be accomplished through timely and accurate distribution of information to policy-makers though multiple outreach methods.

The Plan maintains two primary themes: Outreach and Information. Within these themes will be tactics, practices, and protocols that enable the overall investigation to satisfy the public involvement requirements of NEPA and CEQA for development of an EIS/EIR. The Plan will also integrate those guidelines and/or requirements outlined under Executive Order 12898: "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations;" and the President's April 29, 1994 Memorandum, regarding the engagement of Federally recognized tribal governments in the planning and development of projects.

Outreach

Within the Plan there are four main Outreach elements to assist in coordinating the study efforts. They include (1) Public Meetings, (2) Communication Teams, (3) Tribal Communication, and (4) SMT and PCT activities.

- **Public Meetings –** Two general public meetings are planned for formal distribution and reception of information. The proposed meetings include an open house and public workshop to be held following identification of resources problems and needs, study objectives, and draft Mission Statement in early 2003 and a public forum following circulation of the Draft Feasibility Report in 2005.

- **Communication Teams –** Members of the Area Impacts & Restoration (Air Com) Team and the Water Supply & Reliability (WSR Com) Team will be recruited to include those with expertise in water supply and distribution, water marketing and exchange, ecosystem restoration, water policy and legislation, local interests, regional economic impacts, environmental justice, and others to be identified through the public involvement process. These communication teams will meet three times per year. The AIR Com Team is planned to meet three times per year in the Redding area. Two WSR Com Teams are planned, one intended for the primary study area and a second for interests outside of the primary study area. The two WSR Com Teams will meet an estimated three times per year.

- **Tribal Communication –** Consistent with the President's April 29, 1994 Memorandum, Reclamation will actively engage Federally recognized tribal governments in the planning and development of the Shasta Dam project and will consult with each tribe on a government-to-government basis, to the greatest extent practicable and to the extent permitted by law, prior to taking actions that affect such tribal governments. Under Federal Trust responsibility, Reclamation will provide full disclosure (benefits and negative impacts) of the project, allow time for tribal review/consultation and receive comments and/or alternatives. Public involvement activities for this component will mirror all other activities. Consultation with these tribal interests, however, is the responsibility of Reclamation. Three tribal meetings per year are planned.

- **SMT and PCT Activities –** As mentioned, the SMT is comprised of key policy and decision-makers with direct influence over strategic guidance and congressional authorization of the study. This body is scheduled to meet twice annually prior to major study milestones. The PCT, including the Project Manager and technical experts from various disciplines and organizations to accomplish the investigation, will meet on a monthly basis or as needed to complete various study tasks. Each team will have opportunities to interact with key study stakeholders.

Information Dissemination

Study-related information is planned to be disseminated in a number of ways. Following is a summary of each.

- **Stakeholder Database –** A comprehensive stakeholder database will be developed. Initial information for the database will be obtained from existing interest group databases from Reclamation, DWR, and CALFED. It will be stored in a Web-based database accessible by key project managers. The database will be populated by stakeholders, who will be able to express their preferred interest areas and method of contact. The site design would enable project managers to search stakeholders by name, interest area, organization, location, and other subject areas.

- **Project Brochures –** At least two project brochures are planned; one for the fall September 2003 and one for late 2005. The 2003 brochure is designed to report, in part, on initial alternatives being developed. The second brochure will report on details leading up to release of the final feasibility report.

- **Project Newsletters –** Five project newsletters are planned. The timing of each newsletter will be based on key milestones of the investigation and an opportunity for stakeholders to respond back to the project team.

- **Web Site –** A comprehensive project Web site will be created to provide information about stakeholder functions, project information, project photo tour, project calendar, project contact database and stakeholder response forms.

- **Media Relations –** Media relations tactics for the study will include news releases, media advisories, calendar advisories, editorial board visits, letters to the editor and opinion/editorials. The effort will be flexible in order to quickly react to false or misleading information about the program.

- **Speaker's Bureau –** Outreach for the study will employ a comprehensive speaker's bureau program to present information to affected constituents. Members of the speaker's bureau program will primarily include the Project Manager and various PCT members. The program also serves as an outreach mechanism as it gathers comments and responses while it is communicating information to affected constituents.

- **Information Resources –** Information resources include visual aids (PowerPoint slideshow templates, display boards, maps, charts, etc), information papers, and related templates. The document templates will outline the specific format for all public documents to be distributed. By using an established template, the Plan will have a consistent look and feel to the public and a format that is recognizable at a glance.

CHAPTER VIII
FUTURE ACTIONS

ALTERNATIVES FORMULATION

The next major steps in the investigation are to better define and evaluate potential resource management measures and then assemble the most applicable of these measures into various alternative plans. This will include the concept plans identified in Chapter VI and other potential plans developed through future formulation efforts. Following this, the initial plans will be evaluated, compared, and revised to form a detailed set of candidate plans. From the candidate plans, one plan will be selected for display in the draft and final feasibility report as the Selected Plan. Development of the initial set of alternative plans will be the focus of the next major planning effort for the study.

SCHEDULE

Schedules showing estimated major actions to complete the feasibility study and future milestones leading to project implementation are shown in **Figures 6 and 7**, respectively. A report on initial alternatives to be considered and potential candidate plans is scheduled for the Fall of 2003. A draft feasibility report, including an EIS and EIR is currently scheduled for release to the public and other Federal agencies for review in mid-2005. The final report is scheduled to be provided for Washington level review through Reclamation in mid-2006. Assuming authorization by Congress in 2007, followed by detailed project designs beginning in 2007, construction could be initiated in 2009. The initial phase of construction would include real estate acquisition, continuation of detailed designs, acquisition of necessary permits, and minor relocations. The construction period would likely range from three to six years, depending on the selected plan.

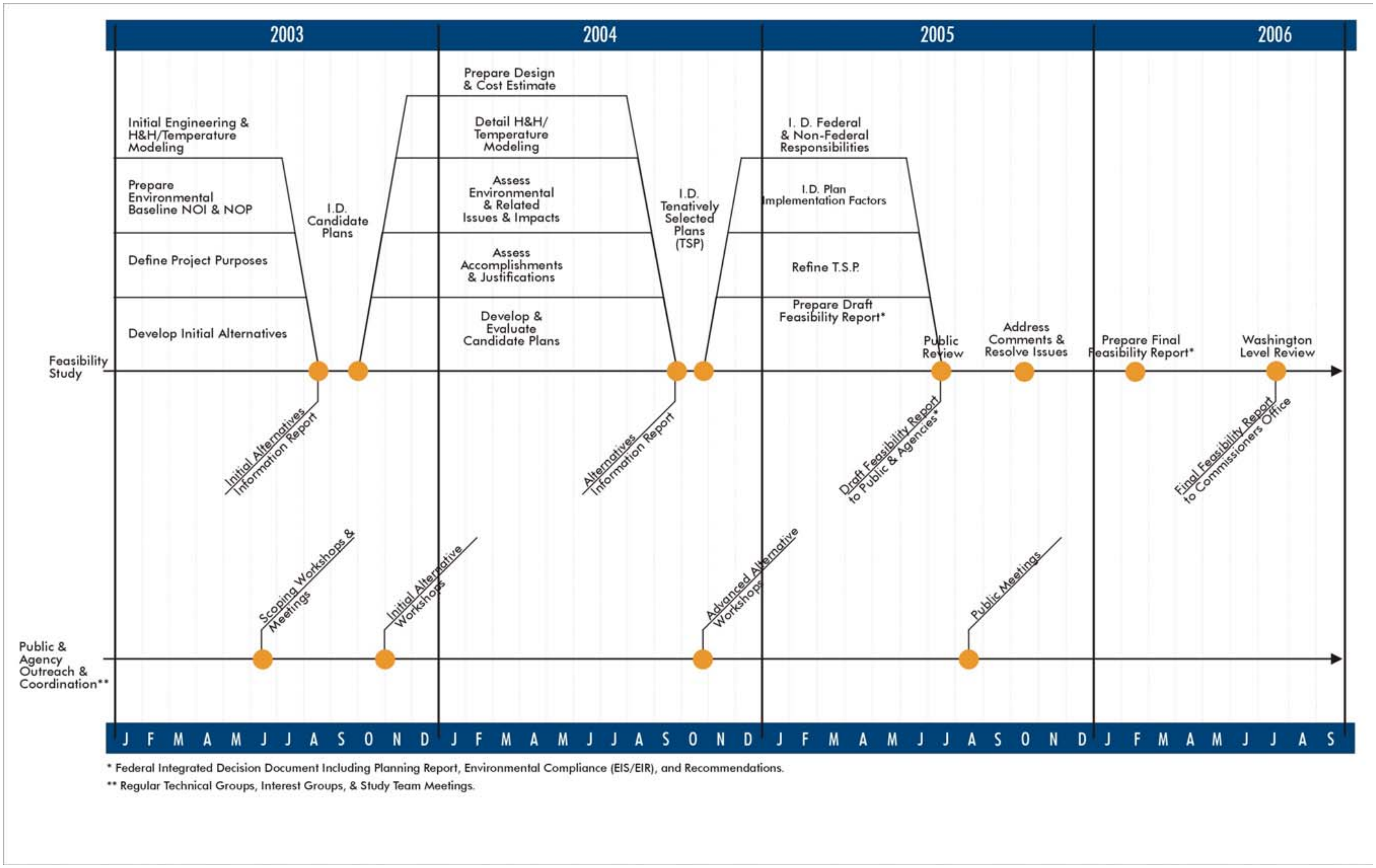

Figure 6 – Shasta Lake Water Resources Feasibility Investigation Schedule

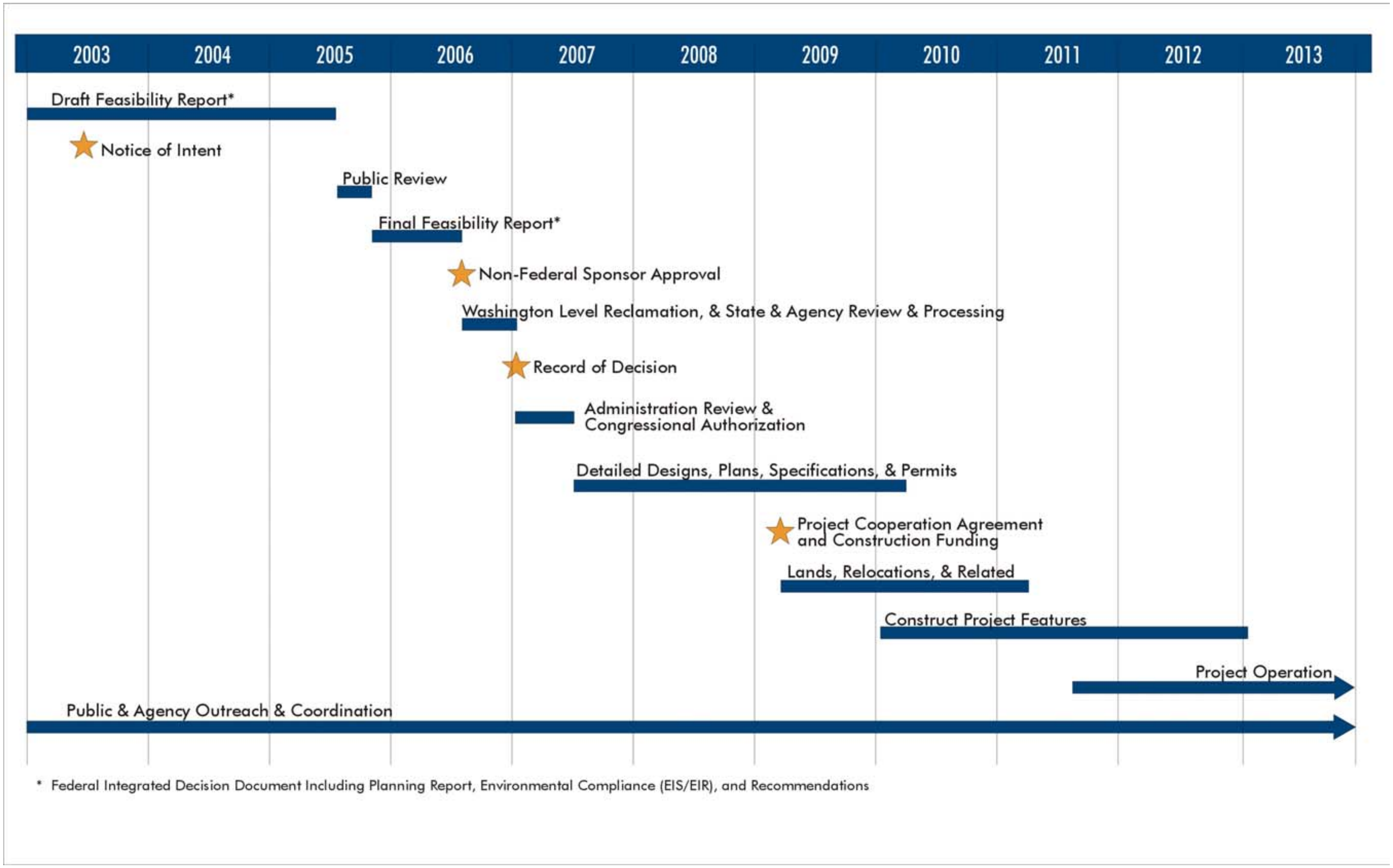

Figure 7 – Shasta Lake Water Resources Investigation Project Schedule

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CHAPTER IX
SUMMARY OF FINDINGS

Major findings of this report are:

- The potential to raise Shasta Dam and enlarge Shasta Reservoir has been found technically and economically feasible in past studies. It is one of five surface water projects recommended for further consideration in the CALFED Bay-Delta Program.

- A continuing significant need exists to implement actions to help increase the survival of anadromous fish populations in the upper Sacramento River.

- Demands for water in the Central Valley exceed available supplies and this condition is expected to become more pronounced in the future.

- To avoid major impacts to the economy and overall environment of the State, development of additional reliable water supplies is needed to meet the future demands.

- A significant need exists to restore ecosystem resources along the upper Sacramento River area including wetlands, riparian, and aquatic habitat, and water quality conditions in the study area.

- Other identified problems and needs include (1) threat of flooding and related flood damages along the Sacramento River downstream from Keswick Dam, (2) need for increases in renewable energy supplies in the State, and (3) need for increased recreation opportunities at Shasta Lake.

- Primary and secondary planning objectives were developed to address identified problems and needs. They include:

  - **Primary Objectives –**

    - Increase the survival of anadromous fish populations in the Sacramento River primarily upstream from the RBDD.

    - Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes to the CVP to help meet future water demands with a primary focus on modification of Shasta Dam and Reservoir.

  - **Secondary Objectives –** To the extent possible through pursuit of the primary planning objectives, include as opportunities, features to help:

    - Preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River.

    - Reduce flood damages along the Sacramento River.

- Develop additional hydropower capabilities at Shasta Dam.

- Provide additional water-related recreational opportunities in the Shasta Lake area.

- A set of constraints was developed to help focus the planning process including: study authorization; applicable laws, regulations, and policies; the CALFED ROD; and various guiding principals.

- Four fundamental planning criteria were highlighted for use in comparing and evaluating developed alternatives: completeness, effectiveness, efficiency, and acceptability.

- On the basis of the tentatively identified problems and needs, relationships to other programs and projects, and Federal planning guidance, the following Mission Statement was developed:

"To develop an implementable plan primarily involving the modification of Shasta Dam and Reservoir to promote increased survival of anadromous fish populations in the upper Sacramento River; increased water supply reliability to the Central Valley Project; and to the extent possible through meeting these objectives, include features to benefit other identified ecosystem, flood control, and related water resources needs."

- Based on a review of preliminary resource management measures, likely concept plans could range from physical means of enlarging Shasta Dam and Reservoir in combination with conjunctive use facilities and ecosystem restoration elements, to a non-structural approach focusing on increasing the efficiencies of the existing water supply and flood control operation of Shasta.

- Public involvement and input will be critical to the success of the feasibility study. A public involvement plan has been developed to help create and evaluate alternative plans.

- Coordination with other ongoing CALFED storage programs will be necessary to maintain consistency and quantify the benefits of a project at Shasta.

- The next step in the plan formulation process will be to better define potential resource management measures to address the identified problems and needs, and using the most applicable management measures, develop an initial set of alternative plans to address the planning objectives.

PLATES